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*Preparing for the future: How to organize warehouse operations
to secure a profitable e-commerce sales channel?*

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Abstract

The background and current setting of the topic and theme of this thesis is how a traditional logistics actor can profitably reconfigure warehouse operations with the purpose of preparing for increased e-commerce activities. The thesis assumes the perspective of the case-company Møller Logistics. A throughout discussion regarding the choice of the case-actor is provided before arriving on the research question:

“Preparing for the future: How to organize warehouse operations to secure a profitable e-commerce sales channel?”

The second section is dedicated towards reviewing relevant academic literature and covers warehousing with process flows, e-commerce, comparative analysis and warehouse model development. The purpose of the literature review is to provide the foundation for theoretical relevance of the thesis while ensuring consistent academic terminology and language.

The third section account for the research methodology in the thesis. A mixed method case study is selected as the appropriate strategy and design. The thesis is developed through a stepwise method, starting with mapping Møller Logistics (ML) current warehouse operations. The following step is a comparative analysis of The Komplet Group. The purpose of the comparative analysis is to provide new ideas for ML warehouse operations from a leading e-commerce actor. From this, a model has been developed in Microsoft Excel™ 2010 to simulate performance in five scenarios with increased sales, and three reconfigured warehouse operations. The calculation shows that Møller Logistics would benefit from reconfiguring the current e-commerce warehouse operation so that it can be integrated with the ordinary flow of goods.

The final section of our thesis discuss limitations of our study, thus functioning as guidance for suggested further research on the topic of warehouse configurations and e-commerce.

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Definitions

General:

- Automated - Partially handling through the use of computer software, machinery and manpower.
- Automatic - Handling using computer software and machinery.
- E-commerce - Electronic commerce, buying and selling of goods and services using an electronic network.
- E-store - Electronic store / online store / web based shop.
- EDI - an electronic system for transferring data from an IT-system to other systems for handling of order information, invoice information and freight- and delivery information (Posten 2016).
- Number transfer - new article numbers from the supplier generated as a result of a slight modification of the product or packaging.

Warehouse:

- Astro - Warehouse management system.
- Autostore - Robotic inventory handling system.
- E-commerce Flow - activities generated from electronic commerce orders.
- Paternoster - Computer controlled vertical carousels that are utilized for storing and order picking of small and medium sized products.
- Micro storing - Storing in Paternoster.
- Ordinary flow - Activities generated from dealer orders.
- Pallet storing - The whole pallet is stored directly in the shelves, without considering fill rate.
- PDA - Handheld computer, handling warehouse operations.
- Volume storing - Not pallet storing, but too large to fit in paternoster. Varies broadly in size and shape.
- Warehouse operations - Overarching segmentation of warehouse activities.
- Warehouse processes - Activities within a warehouse operation.

1.0 Introduction

The specific focus of this master thesis is connected with the overarching topics of electronic commerce (e-commerce) and warehouse management. For the authors, practicality is perceived as an important orientation. Consequently, the implications and solutions provided in this master thesis should be feasible in real life. The master thesis is written in cooperation with a great retail actor in Norway and abroad, serving a large amount of customers through both traditional brick and mortar stores, and also by an e-commerce sales channel. The primary focus of the master thesis is within the proximity of warehouse operations, and the goal is to secure profitability in the e-commerce sales channel by reconfiguring warehouse operations. This topic is highly relevant, as the e-commerce sales channel is perceived as important in order to keep companies competitive. A large number of Norwegian actors have established an e-commerce strategy in parallel with ordinary operations, some new e-commerce companies has emerged, some are in the e-commerce establishing phase, and some are considering entering e-commerce. Therefore, we find a case study of this topic suiting in this particular time period.

The master thesis is organized in 10 sections. The introductory part of this master thesis defines the background for our study, problem statement and main objective. Additionally, an introduction of the case company Møller Logistics is presented before the purpose of the master thesis is discussed. The second section provides a literature review, followed by a review of our methodology in section 3. The mapping of current operations is provided in section 4, before we discuss e-commerce in section 5. Section 6 is the foundation for the comparative analysis, where the results and findings of the comparison are discussed in section 7. Simulation and analyzes is provided in section 8, and we finalize the master thesis with recommendations and solutions in section 9, before we suggest further research and discuss our limitations.

1.1 Background

Companies are interested in how to prepare their supply chain and warehouse operations to better cope with the emergent shift in customer buying behavior brought forward with the innovation of e-commerce sales channels (Gunasekaran et al. 2002). In order to sustain the ability to compete it is perceived as essential

that traditional and ordinary operations are maintained, while simultaneously focusing on online sales. This raises the overarching question: How to configure a future distribution warehouse to handle parallel sales strategies? By parallel sales strategies, we are referring to the traditional based supply chain, and the e-commerce driven supply chain. Through the master thesis, it is identified that reconfigurations to handle parallel sales strategies in a supply chain increases complexity. The latter topic relates to the supply chain systems and activities of distribution and transportation, the handling of incoming and outgoing goods, picking, packing and shipping. Identified challenges are how to organize the warehouse, distribution system and incentives in the supply chain and transportation and how to setup warehouse operations.

Caused by the development of information technology, several actors have emerged to conduct business exclusively through an e-commerce platform. Business examples of such actors are Komplet.no, Skruvat.no and BS Bildeler. As the development of information technology proceeded, related novel ways of business process redesign also emerged, creating turmoil in various industries (Phan 2003). Actors positioned exclusively in the e-commerce segment have critical competitive advantages in terms of e-commerce strategy, IT-business process integration and appropriate systems and infrastructure related to task execution. Conclusively, e-commerce will normally imply rethinking and reconfiguration of the business model, infrastructure and supply chain network (Eikebrokk and Olsen 2007). This can however create ripple effects in other linkages of the supply chain. In this regard it is perceived as essential to avoiding sub-optimal solutions (Christopher, Peck and Towill 2006), especially for actors “new” to e-commerce.

The automotive industry has traditionally handled sales and customer relations by physical presence manifested as “brick and mortar stores”. This philosophy is still present in the current car dealers market. However, some companies providing the market with cars, accompanying equipment and spare parts want to revitalize elements of their concept, by rethinking market perception and introduce e-commerce sales channels. E-commerce are in turn creating new challenges and possibilities for actors positioned in the automotive industry. This market shift is

the motivation for this master thesis, and aims to prepare actors warehouses to handle growth in e-commerce sales.

1.2 Case company: Møller Logistics

Møller Groups (MG) logistics division and distribution center. MG is the Norwegian car importer of Audi, Volkswagen and Skoda. ML is the Norwegian main distribution warehouse of spare parts and equipment for the mentioned car brands. The organization form one of the largest Norwegian logistics actors, serving 124 different drop-off points dispersed within the country. The warehouse itself is a 16.000 m² building at Skedsmo, Lillestrøm. The organizational unit is capable of handling over 2.8 million orders on a yearly basis. At any time throughout the year, the expected tied up capital lies between 100-120 million NOK. Their product assortment consists of approximately 43.000 stocked parts and 90.000 unique parts handled every year, resulting in complex warehouse operations. ML currently operates with three major sales channels named ordinary, emergency and e-commerce. ML's current configurations are created through incremental changes in the organization and can therefore be classified as organic development of business (van de Ven and Poole 1995). They are specialized in performing logistic activities and distribution as part of their supply chain. Their role is wholesale, in which the dealerships order goods. ML's responsibilities include receiving, storing, order picking, packing and shipping of the completed order back to its origination. With increased online sales, ML is in need of reorganizing their setting to a flexible configuration.

1.3 Description of Møller Logistics business model

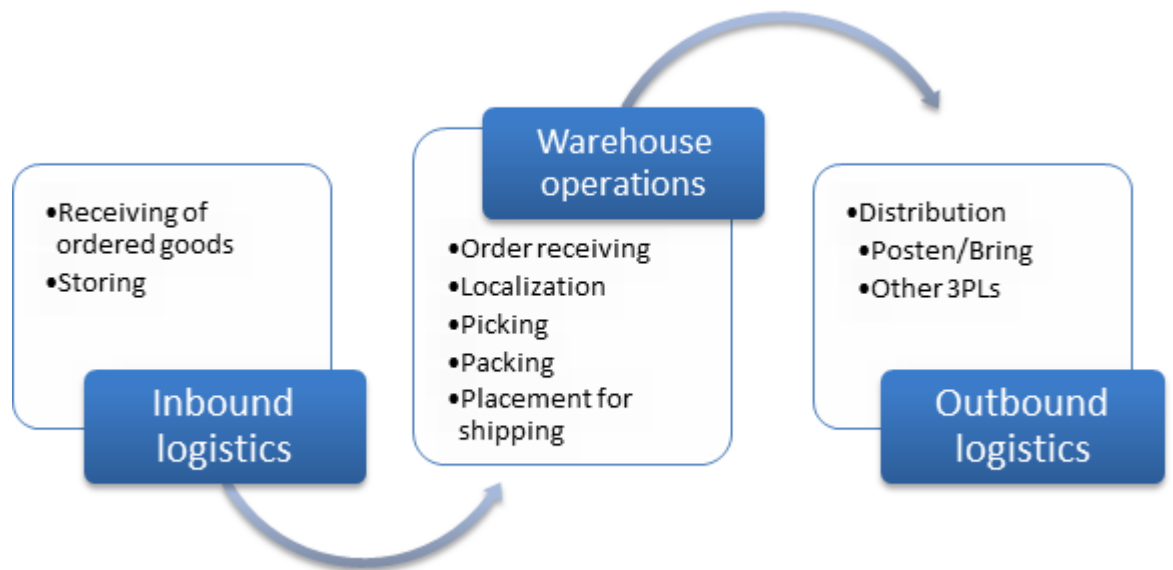
Warehousing operations at ML are handled manually with employees assigned to different workstations and work zones. The IT system Astro (see section 4.1.1) proposes where to store inbound products and immediately pinpoints the stock keeping units (SKU) location for outbound handling and transportation. Astro is capable of handling both the ordinary and the e-commerce strategies in parallel, but there are limitations. Product pickers do distinguish between the processes as they are in different working queues, and the products are delivered to different packaging areas. The packaging operations are separated between the sales strategies. The majority of e-commerce products are shipped to dealers, who also serve as pick up points for private customers, while some are shipped off using

Posten/Bring with the intent of reaching the customers doorstep. Sales in the two market strategies are disproportional, and e-commerce corresponds to less than 1% of total sales.

MG pay attention to the technological changing environment and have launched web stores as an additional sales channel for car equipment, related merchandise and accessories. The goal is that e-commerce will increase overall market visibility, sales and capitalization. This is consistent with the ideas of Phan (2003) which states that integration of IT and e-commerce channels to redesign processes can strengthen e-commerce actor's competitive advantages. ML has developed separate online stores for their imported car brands i.e. "Volkswagenbutikken", "Audibutikken" and "Skodabutikken". The stores sell products such as exterior and interior merchandise and equipment. Technical spare parts such as brake pads and gearboxes are sold exclusively through dealers. ML is however interested in expanding the product selection. A significant proportion of the online product sales go through the dealers for pickup. The end customers visit the dealers to conduct their purchase. ML expects that there will be an increase in the share sent directly to customers, sold through their online sales platforms. With ML's e-commerce strategic focus highlighted, we find the MG's emphasis on e-commerce suitable for a research study.

ML's objective for 2016 is to increase online sales by 400%. On a long time horizon the goal is to increase the revenue with 10 time's current volumes, and even more. ML are highly interested in how to adjust their warehouse configuration in order to be suited to handle these targets. It is expected that this goal will imply new hires, more stock keeping space, overall increased complexity and ultimately higher costs. One of the ideas presented to cope with these issues is to apply a framework of best practice. In order to provide the readers with an understanding of the current warehouse configuration, we have developed the following model describing overarching warehouse functions.

Figure 1: Warehouse functions



In this master thesis, warehouse configurations are defined as all warehouse operations and corresponding processes with the addition of workstation composition with employee organization.

1.4 Research question and problem statement

This master thesis will seek to answer how the e-commerce sales channel affects current warehouse operations, and how the e-commerce sales strategy can be profitably organized in parallel or integrated with existing sales channels. The output of the research are suggestions for re-configurations at the warehouse, and a model that helps company decision makers choosing the organization of configurations at an optimal or close to optimal level. Conclusively, we have derived the following title and research question:

“Preparing for the future: How to organize warehouse operations to secure a profitable e-commerce sales channel?”

In order to respond to this broad question, two sub-questions are identified. Analyzing and answering these questions contribute to reach an understanding of how to achieve profitability in the e-commerce sales channel. For an in-depth discussion of our stepwise process, we refer to the section “3.3.1 Method”. To

generate a quantifiable result, we will work with the cost aspect in the general equation of profitability.

The master thesis will respond to these sub-questions in order to answer the overarching research question:

1. How is ML's online store(s) configured compared to market expectations?
2. How are best in class e-commerce actors securing profitability through organization of warehouse operations?

1.5 Purpose of the master thesis

The study aims to understand how a traditional actor can redesign and reconfigure warehouse operations and the ultimate objective is to secure profitable e-commerce execution. The results of the master thesis should contribute to the decision making process regarding practical organization of warehouse operations at ML, and provide other companies with a framework for conducting similar analyses. The case specific goal is to provide recommendations for how to reorganize warehouse operations given the strategy of quadrupling (and more) e-commerce sales and achieve profitability. The recommendations are based on simulations and scenario planning enabled by an activity based cost model, and supplemented by an external comparative analysis. The purpose of the comparative analysis is to provide valuable configuration information and give practical suggestions for reorganization. The overall purpose of the master thesis is thus to provide valuable insight to established actors that are entering the e-commerce segment, and show how they should align current warehouse operations with this strategy.

1.6 Relevance of the master thesis

The introduction of e-commerce will radically change the logistics of the supply chain and lead to a drastic change in inventory management (van den Berg and Zijm 1999). Facing future market trends, in particular the increased use of electronic media, the integration of inventory and warehouse management issues may prove to be a promising research area.

A descriptive analysis of warehouse operations could be beneficial for future researchers seeking relevant frameworks for comparable supply and value chains.

For companies, such analyzes are valuable for understanding and communicating a holistic visualization of warehouse operations. For scholars and other academic readers, the master thesis handles a highly relevant business issue. Companies are exploring online strategies and consequently re-aligning their supply chains. We are experiencing a shift from existing and mature industries to new and potentially rapid growth channels. The master thesis will improve academic insight of dual sales strategies with different customer segments in the spare parts and car accessories industry. The supply chain may be in a process of change, from old and profitable to new and in growth. In this shift, there is a time that both strategies need to be maintained in order to be profitable. The online sales channel may end up being the dominant in the future, even though it is considered supplemental in the current market situation.

Existing mathematical warehouse models are identified to be too general in their approach to fit specific cases. This results in models with little or no practical application for specific cases. Therefore, our model will contribute on the area of the specific case; how to reconfigure warehouse operations in order to handle a shift in the nature of customer orders.

We have identified that a majority of articles discussing warehouse operations place their emphasis on the order picking process (see literature review). The main area of investigation in this master thesis is attributed to picking and packing in conjunction, and thus expands on recent academia. In addition, the scope of this master thesis grasps all warehouse operations from customer order placement, until the order is shipped from the warehouse.

1.7 Limitations

As our suggestions are partly based on model calculations, we need to account for model errors. The usage of models in research requires simplifications of reality (Hornby 2000), thus there may be elements present in reality which the models do not take into account. Such elements may be variation in employee productivity, errors in measurements, accidents and external delays. As a result, the model is not a perfect replication of reality, but will serve as our best estimate for suggesting re-configurations and measure performance without changing practice and observe effects. Another limiting element is the period of the research. Instead

of conducting a full benchmark, we have conducted a comparative analysis of another actor.

While the overall supply chain is considered, the primary scope of the master thesis is within and about the proximity of the warehouse. Because of this, we limit our model to include warehouse elements, and exclude inbound and outbound transportation. The focus of the master thesis will consequently be more in line with the sets of interrelated activities the focal company uses to gain competitive advantages (Porter 1985), rather than the connected processes involved in upstream and downstream activities towards value creation (Mentzer et al. 2001), but with supply chain considerations without a supply network approach (Persson, Håkansson and Gadde 2010). Consequently, the analysis is more compatible with a value chain analysis. This master thesis's level of analysis focuses on the micro level perspective rather than the meso level perspective (Bryman and Bell 2011).

2.0 Literature review

The purpose of the literature review is to obtain an overview of the existing academic literature related to the topic of the master thesis (Biggam 2011). In the following section, we review the importance of the warehousing role in supply chain management with related operations. Afterwards, we review the topic e-commerce. Our primary focus has been to address current market trends through published reports by large national e-commerce service partners. Finally, we review necessary considerations for conducting a comparative analysis and model empirical findings.

2.1 Terminology and background theory

The warehouse term can be used to describe a facility whose main function is buffering and storage of SKUs or items. If distribution can be regarded as an additional major function, it is common to use distribution center, whereas transshipment, cross-dock, or platform center often are used if storage hardly plays a role (Koster, Le-Duc and Roodbergen 2007). Similarly, van den Berg and Zijm (1999) define a distribution warehouse as a facility that store products from multiple suppliers which ultimately are to be delivered to a number of customers. In this master thesis, we will follow this latter definition. The warehouse generally consists of a number of parallel aisles with products being stored vertically alongside.

The principles of supply chain management underpins the importance of achieving high-volume production and distribution using minimal inventories throughout the supply chain that are to be delivered within short response times (van den Berg and Zijm 1999). In literature, the traditional models for logistics have focused on contributing towards profitability by minimizing costs subject to operational constraints (Sbihi and Eglese 2010). Warehouses plays a vital role in modern supply chains and are critical for the success or the failure of the business (Baker and Canessa 2009; Lu et al. 2015). Main functionalities range from inventory buffering to handle seasonality and variety in demand. Additionally, warehouses deal with consolidation of products from various suppliers for combined delivery to customers (Gu, Goetschalckx and McGinnis 2007).

The product manufacturer seldom manages to meet customer expectations and demands with regard to lead time, while simultaneously operating with a feasible cost structure (Harrison and Hoek 2007). This finding indicates that both the customers' needs and associated costs of operations are better met by being served from inventory keeping facilities. This argument is supported by Li and Kuo (2008) who state that an inventory of spare parts located in a central warehouse plays an important role in improving the service level and reducing the operation cost of automobile supply chains and logistic systems. Since certain markets are driven by push, i.e. storing and selling based on forecasts, the warehouse function is essential to satisfy customer demand from buffer inventory. Pull based markets are more oriented towards production and based on actual sales orders. If markets were driven by pull only, the warehouse function would be more excessive (Tompkins and Smith 1998).

Faber, de Koster and Smidts (2013) define warehouse management as a group of control and planning decisions and procedures. Planning and control are in turn depicted as organizational procedures concerned with managing the ongoing activities and operations within the warehouse system (Rouwenhorst et al. 2000). The main objective is to ensure that the correct stock level is available for each item, the capital tied up in inventory is kept at a minimum, the warehouse capacity is both economical and efficient, the goods are properly kept (Gunasekaran, Marri and Menci 1999) and that these factors ultimately satisfy customer demands (Faber, de Koster and Smidts 2013). Planning as a warehouse management mechanism is proactive while control is reactive. Control is further described as the process of ensuring desired output. Faber, de Koster and Smidts (2013) support the idea that task complexity and market dynamics are the main drivers for warehouse management. The tactical planning horizon is affected by the dynamic environment of the warehousing organization and is consequently in the scope of days or weeks. An additional element in this perspective is the environment, which refers to the immediate external factors that are outside the control of the managers on a short-term perspective.

Pfohl, Zollner and Weber (1992) argue that the theory of economies of scale can be transferred to warehousing operations. The volume effect in economies of scale can be described as decreasing the average unit cost as a result of higher levels of

output within a certain time period with given cost levels. Transferred to a warehouse setting, higher output with unchanged costs leads to increased capacity utilization, and thereby increased efficiency. Efficiency can be achieved by implementing order picking specialization, in which the warehouse is separated in different zones with employees responsible for different zones (Pfohl, Zollner and Weber 1992).

2.2 Warehousing

There is consensus in academic literature towards classifying manual, automated and automatic warehouse operations in four sequential processes: Receiving, storage, order picking and shipping (Rouwenhorst et al. 2000; Gu, Goetschalckx and McGinnis 2007; Koster, Le-Duc and Roodbergen 2007; Faber, de Koster and Smidts 2013; van den Berg and Zijm 1999; Varila, Seppänen and Suomala 2007) Goods are delivered and unloaded at the receiving dock. Here, quantities are verified and sample tests performed in order to validate quality. Afterwards, temporary storage placement is allocated and inventory records are updated (Koster, Le-Duc and Roodbergen 2007). Even in cases where the warehouse itself is fully automatic, the process of receiving often includes some manual processes. The next step is to transport the product loads to the storage area. For documentation purposes, a label is attached to the item. If the internal storage modules i.e. pallets or boxes differs from the delivered goods, the loads must be reassembled in the storage area. When a product is requested, it is retrieved from storage (order picking). An order lists products and quantities requested by a customer. When orders contain multiple SKUs, these must be accumulated and sorted before transportation to the shipping area (van den Berg and Zijm 1999). In the following sections, we elaborate on the warehouse operations, which is defined as one overarching warehouse unit with subordinate processes. As an example, receiving is a warehouse operation, which consists of several processes, for instance unloading and labeling. The described structure can be illustrated in the following model:

Figure 2: General description of operations and processes

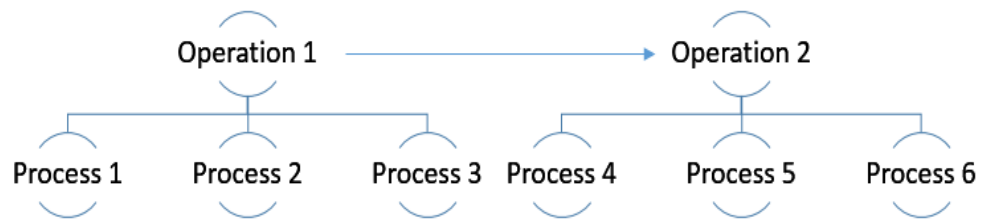
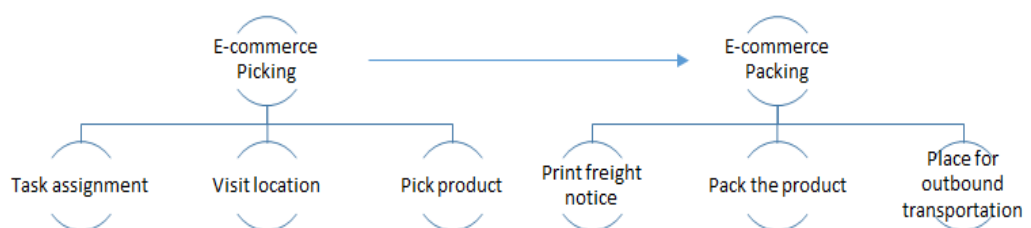


Figure 3: Exemplified description of operations and processes



2.2.1 Storing

Transfer and put away of incoming products to its warehouse location can be classified as storing. This operation can include repackaging, e.g. full pallets to cases or standardized bins, and the physical movement from the receiving area to the different storing areas (Koster, Le-Duc and Roodbergen 2007). Because of this, storage can be viewed as a reverse order-picking situation. Order-picking and storing is both highlighted as complex (Faber, de Koster and Smidts 2013). To align the terminology of our master thesis with academia, we follow the definitions of Koster, Le-Duc and Roodbergen (2007) regarding storage policies or assignment methods e.g. forward-reserve allocation, full turnover storage and zoning. In this context, a storage assignment method is a set of rules that can be used to allocate products to storage locations.

2.2.2 Order picking

Considerable amounts of companies continue to use manual order picking even though other options are available in the market. Some of the reasons for this are several factors and situations favoring manual labor. Among these we find variability in SKUs shape and size, variability of demand, seasonality of products and large investments required for automating the order picking system (Petersen

and Aase 2004). Order picking efficiency is derived from multiple factors such as human resources, internal reward systems, warehouse design, picking equipment, the type of the picked products and shape, size and type of the packaging (Saghir 2004). Order picking frequency and volume is driven by customer orders and therefore varies among industries and companies. Still, Won and Olafsson (2005) state that the order picking operation consumes about 50% of all labor activities in a warehouse. A substantial amount of this activity time is used at traveling distances between products and aisles. According to Bartholdi and Hackman (2011) travel time can be classified as a non-value adding activity and therefore a first candidate for improvement. Koster, Le-Duc and Roodbergen (2007) found that the estimated cost of order picking corresponded to as much as 55% of total warehouse expenses. However, these figures differ in academia. For instance, van den Berg and Zijm (1999) state that order picking corresponds to more than 60% of all operating costs, while Coyle, Bardi and Langley (2002) broadens this to lie between 50-75% of total operating costs. The conclusion is however that the relatively large share of costs directed at order picking has deemed the operation a highly relevant area for cost reduction and thereby improved productivity. To operate efficiently, Koster, Le-Duc and Roodbergen (2007) suggest that the process need to be robustly designed and optimally controlled. There is however no existing orders picking models that can be applied globally. Still, the authors Tangenes and Gjønnnes (2013) suggest that increased operational effectivity can be reached generally by implementing lean principles. The value of products should be regarded from the customer's perspective and all non-value adding activities should be eliminated. Further, throughput should move at a steady phase and a pull-oriented system should be chosen over a push strategy. Finally, successful lean implementation is never fully achieved. Instead, a company should always be on the lookout for continuous and incremental improvement.

According to Goetschalckx and Ashayeri (1989) both external and internal factors, influence the order-picking choices. In this context, external factors can be marketing channels, customer demand, supplier replenishment patterns and inventory levels. Internal factors are in turn depicted as warehouse characteristics, organization, and operational policies. It is however important to note that decision problems related to warehouse characteristics are often concerned at the warehousing design stage. In large warehouses, the pick volume is large and the

available time window is short. A crucial aspect of efficiency is therefore to handle typical decision problems in design and control of order picking processes. This Can be achieved by focusing on order batching, routing methods and zoning, optimal (internal) layout-design and storage assignment methods.

2.2.2.1 Order Batching

To operate effectively, it is essential to balance the tradeoff between warehouse efficiency and customer order urgency. Batching is a method for reducing the time customer orders are in the system, i.e. order holding time. Large batches cause long response time as the time required for picking a specific product increases. Still, small batches are inefficient, as they would require multiple picking routes to satisfy demand (Cachon and Terwiesch 2013). Consequently, both order picking time and order holding time need to be taken into account simultaneously (Won and Olafsson 2005). The problem may be formulated as follows: Given a random number of individual orders which also varies in size, and a constrained capacity, determine the minimum number of batches to be picked together to fulfill the orders. This is a modification of the classic so-called bin-packing problem (Johnson and Garey 1985). The warehouse order batching picking problem is therefore equivalent to finding the number of orders to batch that minimize the numbers of batches, and simultaneously not exceed the capacity.

2.2.2.2 Warehouse routing methods

After the batches are defined, the order picking locations sequence must be determined. This decision is often defined and modeled as a traveling salesman's problem, i.e. route optimization (Daniels, Rummel and Schantz 1998; Won and Olafsson 2005). Given a fixed set of locations, the problem can be defined as finding the shortest route that visits each location exactly once, and starts and ends at the same location. Consequently, the order-picking problem is about determining the sequence of which locations to be visited in order to minimize total costs. Since the warehouse normally receives orders in variable frequency, but continuously, the planning problem must be solved quickly. The traveling salesman problem directs focus on the sequence of the visits in the storage in order to eliminate unnecessary travel time (Won and Olafsson 2005; Lawler et al. 1995). In firms such as wholesaler distributors and distribution warehouses, the task of processing orders is at the very core of the business (Petersen and Aase

2004). Because of the order frequency, small savings in order processing can accumulate to significant cost reductions. One strategy to handle the traveling salesman problem includes the approach of zone-picking and batching (Daniels, Rummel and Schantz 1998). In zone picking, the orders consisting of several products are assembled by multiple pickers assigned to different zones. The result of this is a traveling salesman's problem in smaller areas, which is easier to solve.

2.3.2.3 Heuristics

The objective of routing policies is often to sequence the items on a pick list and ensure a good route through the warehouse (Koster, Le-Duc and Roodbergen 2007). It can be sufficient to employ practical methods that do not guarantee optimality, but rather ensures the immediate goals defined as heuristics. Ackerman and Londe (1980) describe the warehousing setting as a dynamically changing and large work area. Aisles can be relocated and workers are mobile. Worker mobility and the large working arena make close supervision hard. In this setting, the authors state that one of the best heuristic tools in measuring travel distance is Pareto's law, otherwise known as the 80-20 rule. Pareto's law states that a majority of enterprises have 80% (or close to) of demand satisfied with 20% of the SKUs (Sanders 1987). Locating these closest to the shipping and receiving stations will reduce traveling distance and average order completion time. However, in most warehouses, goods are stored in product families (Ackerman and Londe 1980). Other routing heuristics are described by Roodbergen (2001) (attachment 1).

2.2.3 Packing and shipping

Following the definition by Saghir (2004), packaging is described as a coordinated system of preparing goods for safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery. Also, packaging has served as a medium for providing the customers with product information and promoting the products through the visual appearance i.e. marketing (Rod 1990). Further, packaging is recognized as an interface between the supply chain and the customers while being a multi-disciplinary issue that also requires qualitative analysis and methods. While not directly connected to warehouse operations, packing usually finds its place within the same building. The warehouse managers must therefore seek to improve the costs associated with

the amount or type of packaging material, while simultaneously considering cost-effectiveness of transportation (Gunasekaran, Marri and Menci 1999). Packaging has a significant impact on the efficiency of logistical systems as it directly influences the time required for completing operations and delivery to customers (Twede 1992; Lockamy 1995). Saghir (2004) adds to the issue that increased packaging information could improve order filling time and labor costs. The system should consequently be designed to maximize customer and company value. Both Twede (1992) and Lockamy (1995) views packaging as a strategic decision that requires integration in the logistical plans in order to extract supply chain wide competitive advantages.

2.3 E-commerce

In recent years, there has been a major focus on e-commerce and associated growth (Posten 2015). E-commerce is described by Moraar (2008) as a process where two parties are executing buying and selling of goods and services over an electronic network, primarily the Internet. In this master thesis, the scope of focus will primarily be the market for goods. The Norwegian e-commerce goods market consisted of a total volume of around 27.5 billion NOK (2013) which grew to approximately 33 billion in 2014, representing a growth of 20% (Wangsness 2015). In 2014 the growth in the e-commerce segment was four times higher than the traditional commerce counterpart (Virke 2015). Consumers spent on average around 8.300 NOK on online stores in 2013, which increased to approximately 10.000 NOK in 2014. The market is experiencing growth in both number of people performing e-commerce, and the share each consumer are spending. However, e-commerce is still only contributing to a fraction of each household's total consumption; from 1.8% in 2013 to 2.7 % in 2014. E-commerce accounted for 5.2% of the total consumption of goods in 2013, and 8% in 2014. Future growth is expected to come from increased spending per consumer, rather than growth in the number of customers (Wangsness 2015). The most prominent reasons for sorting to shopping through e-commerce channels is that the solutions are flexible and saves time (Dibs 2015). Other important factors are generally lower prices and greater variety in offered articles.

Traditional physical stores meet the customers in person, and are able to meet customer expectations through customer contact and building of relationships and

service. However, when dealing with e-commerce, the customer expectations change. In order to create and earn trust in the relation to the customer, it is therefore important that the trusting party's expectations are met or exceeded (Gefen 2002). This is consistent with the findings of Furseth (2009) which derived that increased customer loyalty can be created through a seamless integration between physical and electronic sales channels. In this regard, seamless integration is identified as identical information, price, product selection and service between different sales channels. One of the normative assumptions for these conclusions is that customers are expected to dynamically change their sales-channel segment affiliation and consequently “wanders” between segments in relations to their current needs and situation (Furseth 2009). Similarly, e-commerce channels directly affect physical retailers. Recent findings show that as much as 64% of all purchases in physical stores are affected by some kind of digital activity beforehand. This includes product and price information searches either by desktop or mobile solutions (Lobaugh 2015). As Ryvarde and Evensmo (2015) describes, several major trends are affecting and influencing e-commerce actors. A first trend is availability of products and services through mobile devices. Dibs (2015) shows that during the last three years, the share of purchases from mobile devices has increased from 20% to 38%. Traffic generated from mobile devices is increasing and a well-functioning e-store on this platform is perceived as crucial to meet and satisfy customer expectations (Ryvarde and Evensmo 2015). Consumers utilize their mobile devices as encyclopedia to compare prices and locate product information. Consequently, companies primarily conducting business through physical stores, can benefit from mobile platform services. A second trend is increased speed throughout the purchasing process (Ryvarde and Evensmo 2015). Customers are impatient and consequently, navigation on the online solution needs to be easy, and loading time must be kept to a minimum. The current successful e-stores provide the customers with seamless solutions without errors or issues. E-store design and functionality are also linked to the logistics perspective, and affects profitability through visibility and availability. Theoretically, availability, or place, originated from one of the four P's in marketing theory and historically, logistics was considered to be part of marketing represented as “place” in the market mix (Zikmund and Stanton 1971).

Regarding order shipment, customers often expect and require rapid deliveries, and the possibility to track their orders during transportation (Dibs 2015). The need for fast handling has historically been the basis for delivery from physical stores and express deliveries. As customers' expectations also include speedy handling of questions and help requests, e-commerce actors are forced to extend their customer services opening hours and provide a rapid response. As a third trend, the customers expect freedom of choice (Ryvarden and Evensmo 2015). The customers want options regarding sales channels, but also payment options such as invoice, credit card and partial payments. Credit card is the preferred payment option, but customers also expect to use invoice, online banking and electronic wallets, such as Paypal (Dibs 2015). The customers' expectations also include choosing between order receiving at home, pick-up in the store or at the postal office (Posten 2015). A fourth trend is the increased focus on established brands (Ryvarden and Evensmo 2015). Historically, producers use intermediaries in order to reach the market. By establishing e-stores, strong original brands can therefore provide the market with products directly through e-stores. Customers may prefer original brands if they can be provided with convenience (Posten 2015). Finally, as PostNord (2016) have identified, it is necessary for e-commerce actors to be responsive and adapt to rapid changes in technology, expectations and trends to succeed and continue doing so. By reviewing these trends, it is identified that success in the e-commerce segment is difficult and both money- and time consuming. Customer expectations are dynamically changing, and businesses need to keep up with the rapid evolving environment.

2.4 Comparative analysis

In order to develop an understanding of performing a comparative analysis, literature regarding benchmarking has been reviewed. According to Gu, Goetschalckx and McGinnis (2010), benchmarking represents the process of systematically assessing the performance of a warehouse by identifying inefficiencies, and proposing improvements based on the findings. The reason for conducting benchmarks is that it allows logistics professionals to learn from others and allows fresh ideas on how to improve operations and boost productivity (Cooke 1996). In order to conduct successful benchmarks, a mapping process of own logistics warehouse operations should be undertaken first. This may be a flow chart of operation activities, processes and costs. The purpose of the

mapping is to provide in-depth insight on own operations. Then, decide how to measure performance and which measures to improve. The benchmark need to search for information that is meaningful to the specific context of the company (Cooke 1996). As a rule of thumb, benchmarked organizations should be best-in-class actors in a comparable industry. The measures (quantitative data) provide indications on what is happening while the qualitative benchmark interprets the reasons behind the numbers. As identified by Hackman et al. (2001), traditional benchmarks has focused on comparing quantitative measures, such as operating costs (warehouse costs in percent of sales), operating productivity (units handled per person per hour) and response time/shipping accuracy. It could be important to note that Hackman et al. (2001) identified these as inaccurate measures for warehouse performance.

Hackman et al. (2001) identified that traditional benchmarks has focused on comparing quantitative measures such as operating costs, operating productivity, response time and shipping accuracy. They argue that these measures are inaccurate for warehouse performance due to the following reasons: 1) Operating costs varies directly and widely with product pricing and sales volumes, aspects outside the control of warehouse management. 2) Operating productivity implicitly view labor as the only resource in the facility. Space and capital investment in material handling and storage systems are ignored. 3) Units handled per person per hour shows this measure as the only output of the facility. Nevertheless, “units” vary in required handling time per unit (Hackman et al. 2001). As a result, meaningful comparisons are restricted to products with similarities. For this master thesis, the approach to the comparative analysis considers several dimensions of warehouse performance and thus makes comparisons of warehouses across a broader spectrum possible. The result provides learning through both the internal mapping process and the comparison with another actor.

2.5 Model

As defined by Hornby (2000), a model is a description of a system which is used for explaining how something works or calculating what might happen. Park and Webster (1989) propose model inputs for usage in warehouse systems. Suggested model elements include maximum inventory levels, number of storage aisles,

picker travel time, labor cost and fuel costs. Total cost of different alternatives should be simulated. Park and Webster (1989) also argue that model results depend on storage structure, product demand patterns, control procedures and product arrival patterns. Amato et al. (2005) suggest a model of how to utilize the warehouse design, and proposes detailed model inputs with lengths, heights and capacities of the warehouse configuration. Rouwenhorst et al. (2000) argues that resources are critical factors in a warehouse model. They refer to resources as all means, personnel and equipment necessary to handle warehouse activities. Hackman et al. (2001) refers to critical resources as labor, space, storage and handling equipment. The different resources may be utilized in different ways, with different implications. Petersen and Aase (2004) categorize these resources in process decisions. They argue that several companies continue to use manual order picking due to variability in products shape and size. However, a model can help with determining how to pick, how to store, and how to route effectively. Petersen and Aase (2004) agrees with Park and Webster (1989) on model simulation inputs, but also suggests capacity of picking equipment, picking time per SKU, storage capacity, storing method, and that demand is based on the classical 80-20 distribution. They performed simulation experiments, and the result shows that batching has the largest impact on reducing total fulfillment time and in particular with small order sizes. While Rouwenhorst et al. (2000) discusses the isolated effect of different resources, Hackman et al. (2001) consider workload in addition to critical resources. Workload are how the practical challenges are solved in the warehouse, e.g. pallet picking, usage of cases, storage and order accumulation. They suggest a model with labor, space and equipment as input, and movement, storage and accumulation as output. When developing a model for application, we need to use a combination of resource inputs, warehouse design inputs, labor, capacity, demand and costs. Also, activity based costing has conceptually been applied to strengthen accuracy on assigning costs (Varila, Seppänen and Suomala 2007). This finding suggests building the warehouse model to consider activity based costing in order to receive comparable results.

3.0 Research methodology

Research methodology relates to the overarching approach to the complete process of doing research. Choosing the appropriate methodology is essential in order to be able to generate correct and valid answers, and contributes to systematically solving of the research question (Kothari 2004).

3.1 Research strategy

Research strategy refers to the general orientation of conducting business research (Bryman and Bell 2011). Research in management has historically been positivistic, and correspondingly quantitatively oriented on a linear deductive path, but is changing towards a realist perspective which may be called more practitioner oriented (Riege 2003). Qualitative research is constructed as a research strategy that emphasizes words rather than quantification and computation of data. Quantitative research utilizes numbers, values and calculations in order to conclude on results (Bryman and Bell 2011). As this research maps the current operations at ML, the corresponding performance, and simulates changes in input and output, a combination of the two research strategies is utilized. The chosen research strategy of this master thesis combines both qualitative and quantitative methods and could thus be defined as a mixed method research (Östlund et al. 2011).

Qualitative data may contribute towards increased knowledge regarding framing the research question. Additionally, data from qualitative methods might enable quantitative methods such as calculations and models. Quantitative data is collected and analyzed with the intent of comparing and simulating results. Consequently, this research strategy enables the authors to acquire in-depth understanding of the context, which permits a holistic perspective.

This master thesis uses semi-structured and unstructured interviews, conceptual and computational frameworks and primary and secondary data to derive results. This adds up to a research methodology consistent with a deductive mixed methods approach (Bryman and Bell 2011). With a deductive position, the purpose of data is to draw conclusions. Our main priority is related to quantitative data collection, while our sequence is concurrent qualitative and quantitative. Still, our intention is that qualitative research should serve as foundation for identifying

themes or practical understanding of the nature of the problem. The numerical quantitative analysis includes internal company documents with overview of costs and other numeric data.

3.2 Research design

Research design is defined as the framework of collection and analysis of data (Bryman and Bell 2011). In traditional research methodology, analytical tools are classified in accordance with the distinguishing schools of qualitative and quantitative research. While it has been common to associate case studies with the qualitative world, Gary (2011) draws the attention towards neglecting this segregation and instead underpins the importance of a pragmatic approach characterized by analytical eclecticism. This is consistent with the philosophy of Stake (1978) who explained that the objectives of practical arts where, in all essence, to get things done. As the master thesis shares these characteristics, the methods for collecting and analyzing data are practical rather than theoretically oriented.

This master thesis assumes the perspective of ML as a single entity and the reconfiguration issue and profitability aspect as a single problem. The objective of the master thesis is to provide solutions for the problem in the form of feasible suggestions for implementation. Specific for the contextual setting of the case in question is the location, strategic event, organization, people, knowledge and implemented systems. Together these elements manifest a complex but observable phenomenon.

According to Gerring (2007) research of a single and comprehensive phenomenon, in a naturalistic setting, where case and context are difficult to distinguish and where the research require triangulation of evidence, can be classified as a case study. Eisenhardt (1989) argues that case studies serves as the necessary research strategy for understanding the dynamics present within a single setting, and is further recommended by Normann (1980) for studies of complex systems where broad conceptual frameworks are applied. Such studies can also be applied to aggregated systems, such as a network, relationship, resource or a supply chain (Bryman and Bell 2011). According to Woodside (2010) the major objectives of a case study can be any combination of description, understanding,

prediction or control where the principal objective for the researchers is to acquire deep understanding of the actors, interactions, sentiments and behaviors that occur in processes.

The master thesis is written in conjunction with the launch of the “e-commerce 2016 commitment project” at ML. In this setting, the researchers worked in parallel with the project as it developed. When the researchers have little control over the events, the contemporary phenomenon can be studied with an objective, in-depth case study examination (Yin 2014; McCutheon and Meredith 1993). Because the researchers want to develop a clear picture of the phenomenon, a case study covers a large amount of data collected within the organization. The primary sources of data originates from direct observations and interviews with involved people. Secondary data can in turn be described as documents and previous records from other authors. Case studies are distinct from historical studies and focuses on current conditions, utilizing historical data mainly to understand the information gathered about the ongoing situation (McCutheon and Meredith 1993). Also, case studies generally exclude influencing capabilities by the researchers (McCutheon and Meredith 1993).

In case studies, general quantitative methods include model building and simulations (Ellram 1996), while the naturalistic lens used to observe the phenomenon belongs to qualitative research (Bryman and Bell 2011). As defined by Stake (1995), the nature of the case study is intrinsic, where a case in itself proposes the research of interest. Based on this classification, the research methods will differ from other categorizations (Simons 2009). According to Flyvbjerg (2006), the combinatory approach of a case study will more often than not allow greater flexibility and enhance the depth of analysis to an extent beyond that of the traditional research methods. Similarly, Rowley (2002) writes that case studies may offer insights that may be unachievable by other research strategies and approaches. Conclusively, a mixed-method single case study serves as the appropriate design for the aforementioned research question.

3.3 Data collection

Research method is related to the conduct of data collection. The data collection is one of the main assignments for processing data and deriving results. To enable

the building of a model, both primary and secondary data must be explored. In order to deliver a suitable model, understanding of the contextual setting is important. Therefore, the first step in the data collection is to map the current configuration. The first data collection phase thus has a descriptive nature (Yin 2014). For comparative purposes, it is pivotal to gain access and extract relevant data of another value chain configuration.

3.3.1 Method

To answer our research question, we have developed the following chronological process flowchart, which has attributed strategic value to our overarching question, and serves as data collection method.

Figure 4: Method flowchart



1. *Mapping of current warehouse operations (ordinary and e-commerce):*

In order to re-organize today's operations at the warehouse, understanding the current setting is essential. The first step is therefore to map the processes, including the warehouse operations generated from the ordinary/traditional sales strategy, and the online sales strategy. The mapping addresses the issue from receiving and storing, to orders received through picking and packing of goods, to related distribution and shipping. All relevant value chain processes and corresponding key metrics are identified.

2. *Analysis of a leading e-commerce actor:* Different e-commerce actors who are performing warehouse activities organize their warehouse operations in various ways. In order to understand the broad variation in design, a comparative analysis of a leading e-commerce actor is performed. This analysis is cursory in the pursuit of best practice.

3. *Comparative analysis:* The comparison will investigate duplication of elements in the different actors' configurations, and if there exist a "best practice". This section will provide a qualitative analysis of methods, operations and processes.

4. *Model development:* In order to simulate reconfigurations on warehouse operations, a model is developed. The model building is based on the mapping of

ML's current configuration. The result is a simulation tool, with fixed and variable factors, which given a set of input, grants measure of resource levels and key numbers. The model handles effects on costs, time consumption, required number of employees and profitability.

5. *Simulate performance effects*: Based on the comparison, suggested re-configurations are simulated in a model. The model deals with costs, time, handling and profitability as outputs. Measures regarding performance and strategic goal achievement are addressed.

6. *Reconfigure warehouse operations at ML*: Based on the simulation, reconfigurations are suggested. This is application of the mapping and the identified best practice. An investigation of the feasibility of the proposed reconfiguration is conducted before recommendations are presented to ML for suggested implementation.

3.3.2 Secondary data

Secondary data consists of data collected in the past or by others (Bryman and Bell 2011). Data available online, in journals and books all fall into this category. We have strived to use academic articles and books as a framework for our analysis. In situations where academic research served as inadequate sources of information, we have sought out secondary data from credible online institutions (e.g. the Norwegian SSB). Only in the case where there were no available or obtainable data from these sources, we consulted other resources e.g. PowerPoint lecture material and online encyclopedias. Such resources can be useful as a starting point for exploring new topics when little is known about the field (Chesney 2006). Concerning the literature review about e-commerce, we have chosen to depend on online available reports from trusted actors. The reason for this is that the researched academia lags behind and/or is outdated regarding the current development of e-commerce issues. Additionally, the literature used is especially applicable for the geographic setting of the studied case both in relation to customer behavior and market size.

Our purpose is to adapt and apply existing models or elements from these data sources to a new case setting. It is important that the warehouse organization and configuration account for ripple effects in the total supply chain so that sub-optimal solutions are avoided. For assessing supply chain configurations, we need

to review supply chain management and value chain literature and theory. Still, warehouse management, operations and logistics are the primary targets for knowledge acquisition. To develop a feasible and quantitative model and simulation tool, it has been beneficial to extract theory from existing frameworks.

The comparative analysis is derived from a mixed type of collective data. The provision of the data is collected through existing sources. However, personal involvement has been a necessity to achieve understanding of the compared actors warehouse configurations, and the obtaining of “hard data” as basis for comparison. This data has been collected by a mix of an interview and a tour through the warehouse facilities.

3.3.3 Primary data

Primary data is input collected by the researchers (Bryman and Bell 2011). This is data acquired by first-hand experience, investigations and collected with regard to the specific surroundings in the case in order to understand the underlying mechanisms in the phenomenon (McCutcheon and Meredith 1993). The nature of a large share of the data may come from the surroundings itself and the atmosphere at the company. Such data collection can be described as absorption of data enabled by the researcher's presence. The contribution is in the form of unprocessed raw data available for interpretation.

In order to map the current operations at ML, observations of-and participation in the daily operations has been undertaken. The purpose of this endeavor is a thoroughly understanding of the problem. Supplementing information are documents, empirical data from ML, order statistics, figures on costs and sales, and other sources that contribute to a clear understanding. Development of own calculations and computations is derived from internal company files, sheets, documents and meetings with key personnel. Indirect access to ML's internal database and ERP-system has been granted. Primary data consist of provided and developed excel files, data files from the IT-system (Astro and M-net) and resources within the company in question. In addition, semi-structured interviews with company co-workers, managers, technical staff and head of e-commerce have been conducted. The semi-structured format ensures coverage of the necessary key points. However, the interviews had an open-ended structure,

allowing the interviewer to explore areas that comes to lights during the dialogue (McCutcheon and Meredith 1993). The purpose of the interviews has been to identify and map the current warehouse processes, activities and flows, which allow the authors to understand the structure of the challenges ML faces. The interviews have revealed critical processes in the total warehouse system and where there are bottlenecks and slack.

With regard to the development of the simulation model, both academic sources and company specific data served as the foundation. Input data is both fixed and variable factors. Interviews function as a basis for which outputs are desired to gain from the model. Amato et al. (2005) suggests model inputs such as rack length (meters), rack height (meters), time to reach the horizontal end of the rack (min) from the retrieve location to the storage, etc. to serve as the models fixed variables. However, as modern software handles such inputs, our model handles inputs such as time consumption with different activities and related costs. The input to the model is developed in collaboration with ML in order to ensure right quantification of reality. Because every theoretical model is a simplification of reality (Pastor 2000), the utilization of communication with the focal company are essential in order to provide a model with practical feasibility and relevance.

3.3.4 Data analysis

When the collection of both secondary and primary data is completed, the researchers must understand, interpret, explain and decode the information (Bryman and Bell 2011). This has been accomplished by analyzing ML's current operations, analysis of The Komplet Group's operations, comparison and model development. The main task of the data analysis is the mapping and comparison of ML's current configuration, which serve as a foundation for the simulation model. As this master thesis's main objective is to suggest re-organizing of warehouse operations and accompanying distribution, the analysis aim to identify relevant variables and possible warehouse adjustments. These identified variables are then used in our model in order to simulate increased e-commerce sales and effects on warehouse operations. Based on the output data from the model, analyses of costs and time is calculated before suggesting new configurations at ML, which may be implemented under a given set of circumstances.

Triangulation as overarching approach is applied. This is the usage of different modes of data collection to assure cross validation (Jick 1979). Interviews, observation and experience based data calculations contribute to the overall objective in the study. However, in order to understand the complex problem, several aspects of ML's activities needed to be studied. Consequently, different collective modes have been applied.

3.4 Quality of the research

In order to ensure quality of the research, three of the most prominent criteria for evaluation are reliability, replication and validity (Bryman and Bell 2011). Stability and quality of the obtained qualitative data is determined by testing validity and reliability (Riege 2003). However, there is no single set of consistent validity and reliability tests for each research phase available in literature.

3.4.1 Replicability and reliability

Reliability and replicability are very similar and concerns questions regarding the repeatability of the study, the consistency of measurements, and to what extent the findings can be trusted (Bryman and Bell 2011). Replicability refers to the repeatability of the methods used in the study, and thus whether the study can be re-created. Reliability is conceptually slightly different and concerns the consistency of the findings. Where it is possible, findings, observations and conclusions from multiple researchers are utilized. Otherwise, congruence has been reached through internal discussion of applicable models

As a supplement to this master thesis, a case study protocol and an interview database is developed. In case studies, a case study protocol can be used to address replicability while a case study database could serve the purpose of enhancing reliability (Ellram 1996). The protocol should include interview-guides as well as the procedures to follow in using the test instruments. When involving multiple data sources, a case study database should include all printed material provided by participants as well as copies of completed interviews, with notes and summaries (Ellram 1996).

The case study protocol for this master thesis includes semi-structured interview guides. The procedures we followed was to provide an attachment, which

generally consisted of an agenda or bullet-points corresponding with questions or topics to be discussed. In order to prepare participants for interviews, we have provided introductory information by e-mail. For the simulation model, restrictions and assumptions will be explained to avoid ambiguity. In the case study database, written summaries of key interviews are provided in the appendix. All secondary data material is stored and clustered according to function in a temporary database. To avoid copyright issues, journal articles, books and other externally owned data sources will not be included in this database. Instead, other researchers need to consult the reference guide provided at the end of the master thesis. Internal company data used as a foundation for acquiring key knowledge is included in the mapping and model sections. Observable data used in the description of value chain activities as well as empirical quantitative data have been recorded.

3.4.2 Validity

Validity relates to how a measurement captures what it is supposed to measure (Bryman and Bell 2011), and is related to the integrity of the conclusions that is generated from research. Validation and verification of data is important to ensure quality and reliable results. Ellram (1996) divided validity in three categories i.e. construct validity, internal validity and external validity. In this section, we will review these concepts and present their implications for our research.

Construct validity is closely tied to reliability and replicability. The concept revolves around identifying and establishing proper measures for the studied phenomenon (Yin 2014) and should consequently be associated with the data collection phase. To ensure construct validity we follow the recommendations by Gibbert and Ruigrok (2010) to develop a chain of evidence and pursue to use multiple sources of information. Additionally, having key informants review the case study research is seen as an important element in establishing valid measures (Ellram 1996; Gibbert and Ruigrok 2010). Two other master thesis-writing groups have assessed and reviewed our research. Fresh perspectives can help counteract single-minded thinking through added critique and reflection around measure efforts. Our peer's primary supplementing assignment is to ensure consistency of our theoretical propositions. Similarly, representatives from ML have reviewed the master thesis to ensure quality and usability for own operations. This review

assess rigor (i.e. accuracy) of measurements as well as ensuring relevance of the practical perspective.

Internal validity or credibility mostly concerns explanatory case studies where researchers are trying to demonstrate cause and effect by an independent variable (Yin 2014). In a broader perspective, and thus applicable to this study, internal validity extends to making proper inferences. Analytical techniques that address this issue are: pattern matching, explanation building, addressing rival explanations and using logic models (Yin 2014). Pattern matching compares an empirical configuration with a prediction preceding data collection. The procedure bears several similar characteristics of hypothesis testing but is more broadly defined. Similar patterns strengthen internal validity (Trochim 1989). Explanation building is an iterative process consisting of making an initial theoretical statement and comparing findings and details of the case against a statement proposition. Logic models can be used to visualize and clarify vision and goals as well as how the sequence of actions will accomplish these goals.

External validity reflects how accurately the results represent the phenomenon studied and concerns generalizability of results. Lack of generalizability has been a major criticism of case studies (Ellram 1996). Single case studies may seem a poor basis for generalization, but such research is studied at length and in depth. It might be inexpedient to seek and derive completely new learning from case studies. Instead, refined understanding of an internalized reality might be reached (Stake 1995). However, case studies may, in some situations, serve as the preferred method of research for readers with aligned epistemological perspective. In this instance the case study in itself proposes a natural basis for generalization (Stake 1978). Our findings can serve as a basis for other researchers and be utilized in other analyses in similar settings. Still, this study is a result of a specific context and with a specific content, and thus, while generalizable to a theoretical proposition, it is hard to fully generalize for universes or populations (Bryman and Bell 2011; Ellram 1996).

This specific case study is particularly relevant in the present time, due to the current market situation, access to technology, modes of transportation and

available resources. To validate our academic sources, high quality sources are used. This is classification of articles based on number of citations, the journals classification or publisher's web page for impact factor, scope or field of study and quartile rankings. Regarding the validation of secondary data from internal sources in the company, we have addressed inconsistencies either by mail, interviews or from author-internal calculation. The primary tool for ascertaining data relevance is to triangulate with company representatives. If necessary, the data is brought up to date with relevant numbers, facts and considerations using own research and investigation.

Interviews are conducted with the intent of understanding underlying structures of the problem. In order to validate our primary data we use semi-structured interview triangulation. The researchers will take notes and observe the interviewees. We will follow Bryman and Bell (2011) approach to rewrite the dialogue with own words while we use meetings as an arena for read back and verification. In our interview setting, the research subjects are asked questions, but also given the opportunity to talk freely.

4.0 Current configuration at Møller Logistics - Mapping of warehouse operations

In the following section, we present our data and accompanying initial analysis of ML's internal logistics. Included in this part is the mapping of the current configuration at ML, both ordinary internal logistical operations and processes, and internal logistical operations and processes generated by e-commerce. A presentation of the warehouse layout is also provided in order to understand the warehouse setting. The mapping process is primarily based on two sources of information. The first one is a process picture developed by Sopra Steria. This picture can be found in appendix 4, and has functioned as our initial basis for understanding the warehouse flow. Other process and task identifications are developed from own empirical observations supported with semi and unstructured interviews with personnel at ML. For mapping distinctive processes, a combinatory approach of semi structured interviews and active observation are utilized. In this context, active observation refers to a large range of observation techniques such as speed process training and execution under the supervision of employees. The following chapter is organized with a separate mapping of the e-commerce activities at the end of the mapping of each ordinary operation where there are differences between ordinary processes and e-commerce processes. This procedure is undertaken in order to more easily compare distinct differences between operations and accompanying processes.

4.1 Information Technology

IT-technology is a significant part of modern businesses. This is clearly visible at MG, as they utilize several different IT-systems, IT-solutions, integrated systems, un-integrated systems, electronic stores, and warehouse management systems. This section covers the usage of relevant IT-technology. In order to distinguish between functions, a segmentation of warehouse management system and e-store system is provided.

4.1.1 Astro - Warehouse management system

Before the detailed presentation of the current warehouse operations at ML, it is beneficial to gain basic knowledge regarding Astro, the warehouse management system at ML. With this new warehouse system, which was recently been implemented, there was a requirement for change and restructuring in the way the

employees performed their day to day work. In addition, all employee system knowledge was reset back to scratch, leaving every employee at the same knowledge level. The result of this was difficulties in stepping in on system areas where the employees lack experience, which leads to a higher time consumption than optimally necessary. Another result is challenges with employee education and learning, since the average knowledge level was low. Take-away from this is that a new warehouse system requires time to fine tune into an “optimal” frequency. Even though “childhood illness” occurred, ML was prepared for this, and ready to put in extra resources in certain periods. When we performed our study, Astro was running smoothly and was considered implemented and running. However, Astro was still in a tuning process for gaining the optimal fit.

The Astro system is a standard warehouse management system, based on whole-pallet logistics, and is developed by Consafe Logistics. Because of the company internal customization, the system is able to handle single units as well as pallets. The system is further designed to handle all warehouse operations. Implementation has created both systemic and organizational challenges. One employee shared some thoughts regarding the process, stating that the prior knowledge acquired in the “old system” was comparable to that of the managers. The Astro system has effectively made this knowledge obsolete and is thus bringing a majority of the employees to the same level. Some may experience this as a relief and an opportunity while others lose their position as more knowledgeable. Astro is capable of handling all warehouse operations, from receiving to packaging and distribution. The system is designed as a complete warehouse system solution with functionality ranging from suggesting where to store goods, to optimal picking routes. Astro organizes the incoming order flow in different queues, which leads to different working zones. Orders in a queue can be segmented in accordance to priority. To fit the specific aspects of ML, Astro is customized and integrated with MGs internal IT-system called “Møller Nett”.

4.2 Mapping of warehouse operations

This section is an in-depth analysis and description of ML’s current warehouse configuration. In our mapping, we firstly map all of the identified warehouse operations, which are separated in the different warehouse operations:

- Receiving
- Storing
- Picking
- Packing
- Shipping

Every operation contains different processes and activities. The goal with this mapping is two folded; identify similarities and differences in operations generated from the two different sales channels: ordinary and e-commerce. Secondly we identify process locations, which can be improved through changes.

4.2.1 Receiving

The operation of receiving is integrated and identical for both the ordinary and e-commerce flow. Inbound transportation or receiving can, based on mode of transportation, be divided in two process flow-charts that intersect in the transition to storing. Inbound products are either transported using railway or trucks. Goods transported by railway (Internal naming: AO2) consist primarily of original branded spare parts and are coordinated by an operative leader at the goods received area. Reception is prepared while the goods are still in transit. Railway shipments include a receiving note from the supplier in the form of a data file that contains information about the received products. This is especially important as this process capture deviations from orders placed to actual delivery. Specifically, the datafile contains information about how many parcels delivered, and parcel type. The function is made possible as the main supplier in Kassel and ML has an integrated IT system.

Astro extract transportation-, sending-, parcel-, and article batch information from the datafile and immediately stores this information in a hierarchical structure. “Transportation” contains information about location on the train (carriage). “Sending” contains information about type of sending, such as cage, basket or pallet. “Parcel” information concerns the content of the sending, such as number of boxes in the cage. Article batch information is information about article lines, which is the number of products with the same article number. This information is utilized to prepare the warehouse for the incoming goods.

Arrival registration is performed on the Personal Digital Assistant (PDA); the command is arrived ILAG (in-warehouse). Warehouse handling employees chose loading on the PDA, and scan the parcels with a hand scanner. Number of products per parcel is confirmed by writing the appropriate number in the PDA display. A printer connected to the PDA prints a label that is tacked on parcel or product (vary due to different parcel characteristics). Then Astro defines where to conduct the preliminary sorting process and where to temporarily store products. This is usually within or at the railway platforms proximity. Smaller products are placed in baskets, which are designated for specific storage areas and the label applied at the basket is scanned. Then, the shipment has status as a warehouse parcel and is ready to be transported at its designated storage location.

Goods received by truck often from third party suppliers and mostly accessories) follow a different flow in Astro named A03. The difference is mainly a result of lacking the receiving data contained in the railway shipments. The basis for data input in Astro is therefore generated with information from the initial order. The order is received and confirmed to the right destination for sorting, often ITIL (in-accessory). Warehouse handling employees need to generate parcel notice based on actually received articles. This routine adds an additional step compared to the A02 process. Finally, number of products received is confirmed by manually counting, and the process continues in line with the description in the A02 process.

Truck deliveries are classified as either ordinary or special delivery. Ordinary orders are unloaded by personnel from ML and the truck drivers, labeled and placed at an intermediate storage area. Deviations regarding specified quantity and quality is logged in excel and sent to the purchasing department for further handling. If there are no deviations, the goods are logged. Afterwards, the shipment is identified through the supplier and article number. The goods are finally registered in Astro.

Special shipments follow a different procedure. These are either classified as parts that normally are delivered by railway or special orders containing reserved spare parts designated for dealers or parts going directly to stock. The goods are

delivered by a designated truck from Kassel and follow the same procedures as identified in the A02 step except if they are reserved for suppliers, in which case they are handled separately under the label A05. Special orders following the latter pathway has its cargo unloaded in proximity of a transportation area where the goods are physically examined for damages. After this, the goods are registered as received in Astro and the items are activated and sent to the unit for special order handling.

In the special order handling unit, the goods destined for Oslo are sorted and categorized for customer shipments or warehousing. The warehoused goods are placed at an intermediate storage area before they are assigned shelf space by Astro. The goods following the customer pathway are, based on label, manually loaded in distribution trolleys. From this, the products are further sorted in dealer boxes.

4.2.2 Storing

The storing operations are integrated for the ordinary and e-commerce channel. All products sold through the e-commerce sales channel are available for purchase through the ordinary sales channel. Consequently, there are no additional storage locations related to e-commerce. The storage area is divided in dedicated zones for each product storage type (see attachment 5). The layout is also described in section 4.3. Overall, product storing locations is considered dynamic (not fixed) for ordinary storing. Also, in cases where the location is fully stocked, Astro proposes an alternative location for storing.

There are two main alternatives of performing storing; to buffer or to picking. Buffer, or overstock, are volume products with high turnover. Buffer products are stored at specific locations and are generally less reachable compared to picking locations. Goods designated for picking are stored in zones designated for storing to picking processes. The actual storing is performed by personnel who handle one box at a time, sorted in the receiving operation. The parts or cartons in the boxes have already a label from sorting. This label is scanned, and Astro suggests storing location based on empirically placement, and on available capacity and type of working zone to store the different types of products. The location defining phase is initially done in Astro the first time the unique article number is

stored. For the day to day operations, Astro keep records of where to store different type of products. To tell Astro that you store articles on the suggested location, you scan the label on the location. When the products are stored at the preferred location, a message to Balance Changer is generated. Balance Changer is a complementary module in Astro that monitors warehouse inventory level and product availabilities such that the dealers have eyes on product availability.

Ordinary orders are controlled and distributed to material handling areas while whole parcels are directly stored in the buffer area. Partial parcels are controlled, using Astro, then the function “close shipment” is executed before a visual control is conducted by the production leader with the purpose of assigning the appropriate resources for storing. In the handling unit, the forklift drivers select the appropriate tool for the job and log their selection using a location specific whiteboard.

The parcels are categorized as volume, pallet and micro. Micro parcels are stored in designated locations and the parts are already sorted in blue boxes from the material handling area. Goods are scanned by a hand-held scanner or by PDA. If there is not enough space available the parcels are split and excess material moved to a new location.

Volume parcels are transported using specialized forklifts, while pallet parcels are transported using “picking trucks”. These are classified as either heavy, light or usual. After this procedure the goods are scanned and driven to location one by one or in batches. If there is not enough space available, Astro is consulted and the parcel stored at the next location. To assure correct location, goods are either scanned or registered using a control code. If the location is wrong, Astro will notify the employee and direct them to the correct space. If the location is correct, the number of goods and article ID is controlled before products are stored. If there is not enough space available, Astro will notify the employee and propose a new destination.

4.2.2.1 Storing challenges

By actively observing shelves and racks within the warehouse, there is identified variable utilization in the different warehouse locations. This is because Astro

functions with floating location in different warehouse areas, and does not relocate more than one product to one location. By reorganizing selected warehouse locations and reviewing the “re-order up to” policy, the warehouse rack utilization would increase.

The variability in size and characteristics of products at ML hampers the possibility of achieving a complete standardization with regard to product shelf space. The first picture below shows a technical component, delivered to ML in a steel-protective frame. The shelf is fitted by a rail system that ensures that the component is stored safely in place. Even though Astro generally assigns dynamic locations to products, this SKU cannot be stored anywhere else. Still, other SKUs are storable at the specialized shelf position. Effectively, the technical component has to be stored at the specialized location, while the location also is adapted to store a multitude of other products. Another example is found in picture 2, which shows storage space dedicated to car bumpers. The rack is customized to fit with the dimensionality of the bumpers and is unsuitable for storage of other parts.

Picture 1: Specialized storing



Picture 2: Bumper racks



Some of the other storage areas are highly standardized and is thus more able to handle dynamic location. Picture 3 is an example of a specialized rack for the use of volume products. The shelves feature a plastic rail for successful storing of blue or grey colored cages. The cages are in turn fitted with cardboard to compartmentalize and separate two different products.

Picture 3: Standardized cages



Picture 4 shows large volume products stored underneath racks. Product size varies greatly and the racks are fitted with yellow railings. The space between two railings defines one unique location.

Picture 4: Customized shelves



Picture 5: Car glass storing



Conclusively, there are possibilities for keeping storage space standardized, but only within certain product categories. Full standardization is hardly obtainable.

4.2.3 Ordinary picking

The picking processes begin when customer orders are received. Production managers manually activate orders in Astro. This command generates picking assignments and order queuing systems for the handling employees. The

managers thus assign employees to different zones and workstations by listing the required tasks on a physical whiteboard. The work is structured to serve the “Oslo” area first and subsequently the rest of the country. Picking employees are assigned to different dedicated picking zones. One example in this regard is “The floor” which is counted as a work station with separate queues, respectively K, P, O and M. Effectively, “The floor” denotes the picking work stations where products are stored closest to the ground and where order lines are picked from cages at the floor. Pickers assigned to “the floor” use equipment specialized for temporarily storing goods that can be reached by the employees themselves (“The car”). Similarly, the queues K, P, O and M have workers that are performing picks in parallel at the “height” area. These picks are located on higher shelf positions where a forklift is required to reach the products. Additionally, both paternoster and “volume” have their own queues with corresponding equipment. For all areas, Astro calculates an optimal or close to optimal route with corresponding order batch sizes in the different zones. Employees follow this route picking suggestion to a reasonable extent.

If classified as micro, the order is registered and activated in Traficom and picked from the paternoster by handling employees. Traficom is a fixed minicomputer and scanner, which are receiving orders and monitoring picks and accompanying remaining stock, as Astro and the PDAs. The paternosters can be described as computer controlled vertical carousels that are utilized for storing and order-picking of small and medium sized products (Van den Berg 1996). The paternosters are setup to locate pick assignments such that the paternoster takes one round. A rough sorting is performed on a trolley at the packaging area, before the pickers perform a detailed sorting procedure in dealer boxes, where both products and boxes are scanned for registration purpose. Dealer boxes can be described as a customizable and environmental friendly box with base area about the size of a Euro parcel. The detailed sorting box is scanned and placed in the dealer box before packaging is conducted.

If the order is non-micro, resources are allocated to the order based on need by the production manager. The production manager monitors all incoming orders, and assigns different tasks to different handling employees. An assessment of the need for resources is performed based on number of lines in queue. The

whiteboard/Astro is used as an organizing tool. The handling employees utilize the whiteboard/Astro for self-assignment to prioritized tasks. Necessary tools are gathered, and the employees log in to the PDA on the truck used for picking. Astro then locate the products location in the storage.

The actual order picking is performed from the pallet and volume area (See section 4.3.) To validate location, the shelf is either scanned or a reference number is typed in at the display on the PDA. Astro will automatically ask to confirm the number of products. Confirmation is executed by typing the correct number and pressing OK. Following, an order line label is printed out on mobile printers that are connected to the picking car. Labels are tacked on products based on order lines, not each and every product, and independent of the number of items in the order line. If the products are supposed to be visible in the dealer's stores, the labels are tacked on plastic, which is wrapped around the products. This applies for example for wipers. In addition, some products have an expiry date, which need to be verified when picking. The order lines are then sorted on the trolley on the car based on packing destination (dealer box). If employees for some reason are unable to finish the picking tour, then the order can be released and completed by others. This also implies that a picking tour is locked after choosing.

The handling employees have to determine if the order is large parcel or not. Large parcels are products too large to fit in the dealer box, and therefore in need of separate shipping bills, meaning separate packing. All other (smaller) parcels are placed in the dealer boxes. If the order is classified as large parcel, it is picked and packed separately. If the order line is not large, and the part is fragile, the part is placed in the far end of the cage, or on top of the other products. Some products also have restrictions on how they are to be stored during transportation (and warehouse storing) to the dealers. As an example, children's car seats are supposed to stand on a specific way. Further, non-fragile parts are scanned and sorted to the right dealer box, using Astro as organizing tool, until the order is fulfilled, and all order lines are sorted in the correct dealer box. The complete dealer box is then scanned and registered, ready for final packing.

4.2.3.1 E-commerce picking

Orders generated from e-commerce and “emergency orders” follow a separate process queue than the ordinary picking process flow. The system is organized as a single workstation at the same area in the warehouse, but with separated order queues. Currently, one employee is assigned to each queue. The orders are automatically activated in the employees PDA, and Astro suggests picking route based on order lines and picking locations. The system handles up to 9 different product picks per tour. When an order picking assignment is handled, the PDA print out a product notice, which is placed on the product/order line when picked. When all products on the tour are picked, the picker returns to a designated packing station/area. As the daily number of e-commerce order size averages 9, there is capacity left for the employee to help with the emergency order queue. Both order queues are continuously filled with orders and accompanying picking assignments are automatically moved in prioritized sequence. This continuous handling process are allowing both dealers and private customers to have their products shipped as soon as possible and most often within the same business day.

4.2.3.2 Picking considerations and challenges

Astro manages to calculate optimal solutions to the traveling salesman problem and therefore compute optimal picking routes for the selected product pick limit. These routes are not always followed in detail. In a proportion of the picking cases it may be expedient to add leeway as this increases flexibility and adds a solution for cases where other pickers are blocking access to the pick location. This occasionally happens when equipment used for “height” and “ground” queues are utilized in the same zone. In these cases, one of the pickers can choose to wait or move to the next item on the picking list and from there go back to the initial location when space is free. The additional employee from e-commerce will increase the possibility of “block” occurrence.

Another challenge occurs when e-commerce and emergency picks requires to use the paternoster. The emergency queue has priority, and is allowed to interrupt other ongoing picking processes in the paternoster zone. Employees assigned to the paternoster picking station have to move away from the workstation, and effectively put their current process on hold. The e-commerce picker steps in and performs the intended pick, and leaves the paternoster picker to continue their

ongoing processes. This hierarchical solution is based on the emergency order priority but is also applied to the e-commerce picking.

Another consideration is that the picking efficiency largely depends on the picker itself. In fact the variability between picker performances is large. There are several reasons for this, the most substantial being experience. In addition, optimal routes are not always followed, which may increase overall time used. However, dedicated employees find their own optimal route, and these routes often seem more optimal in practice. The reason for this is capacity issues between the shelves and racks. For example, if there are two or more pickers already between two shelves, and another picker is sent to the same location for optimal route picking, the picker often skips this location, and visit it on the way back. This is easily solved in practice, but Astro do not manage to account for this capacity restriction.

4.2.4 Ordinary packing

It is the same employees who are handling both picking and packing. The first step in the packing process is to finish up the packing of the customized boxes by building the walls in the dealer boxes, sealing and strapping. The actual boxes are made of wooden material and metal to secure the corners and walls. This step also includes creating shipping labels in Astro. Then, the trip is closed in Astro in order to generate packing slip, loading list for dealers, EDI transfer (transportation information distributed to the transportation company and the dealers), invoice to dealers, notice on dangerous goods, and freight notice. Then, the order is completed, and ready to be shipped.

Picture 6: Example of dealer box



The dealer boxes have fixed locations, designated for each dealer. This is done to simplify both packing and shipping. The dealer boxes designated to Oslo area are shipped around noon. When “Oslo” is shipped, the same area in the warehouse is then used to pack dealer boxes to other regions with shipping around 17 o'clock. This is illustrated in the figures below. “Oslo” represent dealers located in Oslo, “other” represent dealers located in other regions in Norway. Notice that the figures are meant as illustrations and do not correspond to the correct number of rows and columns.

Figure 5: Packaging organizing before noon

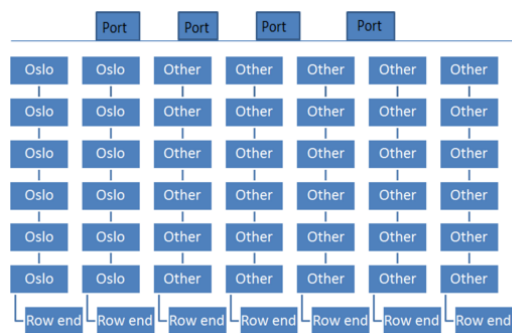
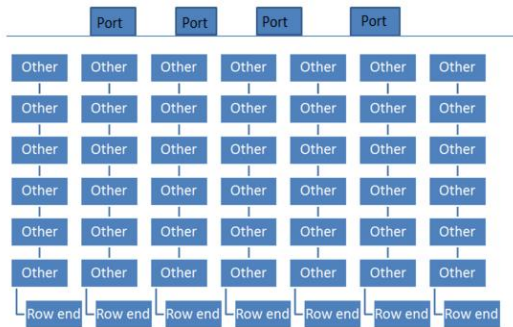


Figure 6: Packaging organizing after noon.



Picture 7: Packing area overview



4.2.4.1 E-commerce packing

When the e-commerce picking tour is complete, the employee has filled the truck/car with products needed to be packed. In addition to physically pack the products, the process requires the use of a computer with Astro software and a scanner. The product notice is scanned and a semi-manual batch-converting procedure is initiated in order to generate freight notice. The procedure involves using a computer program to convert the e-commerce coding as a unique dealer to instead be a part of another shipment. Next, the freight notice is printed and placed on the product or cardboard box. Large products are placed directly in dealer boxes unless they are classified as fragile or too large to fit. The procedure to follow in such an instance is to place it at the backside of the designated dealer-box row. Some products are sent directly to customers with postal service. In this case the products are defined as packed when placed in a cage. Dealer boxes have their own designated area, but boxes destined for Oslo are handled at the start of the day. Thus there is a shift in Oslo dealer boxes, which are replaced by those that are to be delivered at other locations in Norway. In cases where the appropriate dealer box is not present at the time, the products are temporarily stored at a separate table with limited capacity in the packaging area.

E-commerce orders are continuously picked and packed by the same employee separated from the ordinary flow. The current setting is that there are two tables where employees handle all e-commerce activities after customer orders are placed. The largest share of e-commerce orders (79%) are delivered to dealers and picked up by customers at the nearest dealer. Therefore, the e-commerce orders have to be sorted in the same dealer boxes as the ordinary flow. Consequently, an extra tour is needed for the appropriate dealer boxes. E-commerce orders for home delivery are placed in a cage, and picked up by Bring.

Picture 8: The E-commerce table



4.2.4.2 Packing considerations and challenges

The temporary storing process related to the e-commerce packing activities is partly a consequence of the Astro e-commerce flow failing to conjoin shipments with the appropriate dealer boxes. As the packing table and temporary storage area is shared by two employees in separate queues, there are days where products are placed in such a way that it hampers the other employees packing situation. The problem is not a major one as the low volume generated from the e-commerce sales is easily dealt with by manually clearing space. Still, the problem is reoccurring and there generally seems to be no systematic way of structuring the limited space available. Other factors that come into play are that other employees are using the area to store their means of transport (such as scooters). Conclusively, the e-commerce packing solution is characterized as an additional operation attached to a separate operation. There is a lack of integration between the different internal software and this is generating additional and non-value adding activities. The e-commerce packing activities are mostly unable to capitalize on the economies of scale possibilities that are available within the span of warehouse operations. This is because the operation is separated as a queue on its own and is thus not benefiting from the zone organization that is otherwise present within the warehouse.

Other challenges are found in the systemic integration between ordinary and e-commerce flow. The semi-manual batch-converting procedure for e-commerce is undertaken because of registration purposes and one of its outputs is to log and use the correct packaging material. However, in cases where products are unable

to fit in the packaging there is still a need to complete the procedure. In such cases, a theoretical packaging is registered, but the product itself is left as it is. As a result of this, several shipments are registered as packaged when in reality the product is shipped without their packaging or with the original packaging material that were received from the manufacturer.

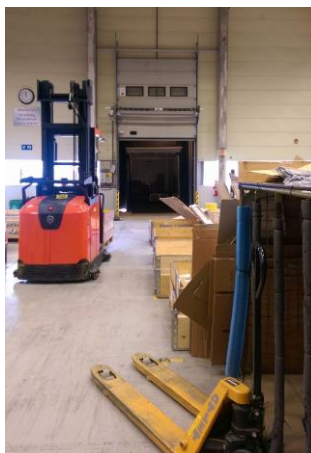
4.2.5 Ordinary shipping

Employees responsible for order handling are helping the transporter loading the trucks with the dealer boxes. The transporting company has drivers who know their way around ML's warehouse, and are able to locate readied shipments, and load the trucks correctly. Most often, it is the same drivers that perform the shipments from day to day. ML cooperates with Postnord logistics for outbound transportation of dealer boxes. Posten/Bring is utilized for transport of goods between ML and their main office in Oslo.

4.2.5.1 E-commerce shipping

The shipping operation is identified as mostly similar between ordinary and e-commerce flow of goods. One difference lies in the utilization of postal service to reach a minority (21%) of e-commerce customers. Posten/Bring is responsible for home deliveries to consumers. Orders sent by postal services can be tracked by using Brings own tracking system. E-commerce orders sent from ML to the dealers (79%) which utilize ML's own dealer box system, lack the possibility of tracking. This is because e-commerce orders are listed with its own systemic dealer-coding. Astro manages to distinguish between ordinary order queues and e-commerce order queues, but fails to understand that orders may be cross-docked.

Picture 9: Overview of shipping area



4.2.6 Mapping summarized

A summarizing comparison of the mapping of ordinary generated operations and e-commerce generated operations is provided in the table below:

Table 1: Summarized comparison of ordinary – and e-commerce generated operations.

Operations	Ordinary	E-commerce
Receiving	No separation	No separation
Storing	No separation	No separation
Picking	Different queues based on zones - aggregated order line picking assignments	Own queue - Individual order line picking assignments
Packing	Dealer boxes	Separate packing, then dealer boxes/postal cage
Shipping	Dealer boxes by Postnord Logistics	Dealer boxes by Postnord Logistics and home deliveries by Bring

4.3 Warehouse organization

An illustration and explanation of the warehouse layout and how the warehouse is organized follows in this section. The zoning and flow of goods is organized as shown in figure 7. A more detailed figure can be found in the attached figure developed by ML, see attachment 5.

Figure 7: Warehouse layout, overview level



As the figure illustrates, the total ground floor is 16.000 m². The total storing capacity is however 21.963 m², and correspondingly 20.033 m³. This is because the warehouse contains shelves and racks, which enables storing in the height. The storing types vary, because the product portfolio at ML is very broad, from tiny bolts to large bodyworks. As the process is today, goods are received by truck in the lower left corner, and by railway in the bottom. The goods are manually moved to the receiving area for unpacking and sorting. Some of the receiving orders are moved directly from receiving to packing, if there are any special orders. Some of the goods are temporary stored at temporary locations in the receiving area for later handling. Examples of such products are rims and other large volume products. Based on the dimensionality and nature of goods received, the products are stored at the pallet zone, the volume zone or the micro zone after sorting. The micro zone holds small products, which is stored in the paternoster.

The paternoster system contains boxes of different sizes capable of storing different type of products. The paternoster boxes vary in size; from 0,01 m² to 0,49 m², and 0,001 m³ to 0,18 m³. The volume area is used to store products directly in different types of shelves. The shelves contains different storing types, such as standardized shelves, square shelves, battery area, custom baskets, side parts, manifold shock paper and bumper racks. Products received on standard euro pallets are stored directly on the pallets in the shelves, and picked continuously from the pallet. Empty pallets are supposed to be removed immediately from the shelves when empty, to release capacity for new full pallets. This organizing makes it doable for handling employees to perform picking. The final station is the packaging section, where packaging is completed. E-commerce packing has a designated area in the bottom left packaging corner, where there are two designated tables for e-commerce and emergency orders. Outbound ordinary shipping happens by truck, which is loaded using the loading bays in the outbound area. The capacity of the warehouse locations is summarized in the below table:

Table 2: Table of location capacity

Warehouse layout			
Area	Type	Share of m2 capacity	Share of m3 capacity
Micro	Paternoster	7,2 %	1,3 %
Volume	Standardized shelves	26,6 %	13,3 %
Volume	Square shelves	1,6 %	2,1 %
Volume	Battery area	0,2 %	0,2 %
Volume	Custom baskets	30,2 %	38,7 %
Volume	Side parts	0,4 %	1,0 %
Volume	Manifold shock paper	0,5 %	0,9 %
Volume	Bumper racks	11,0 %	14,3 %
Pallet	Shelves	22,4 %	28,1 %
Sum		100,0 %	100,0 %

Picture 10: Overview of receiving area



Picture 11: Overview of pallet area



Picture 12: Overview of volume area



Picture 13: Volume - shelves



Picture 14: Pallet - standard



Picture 15: Volume - standardized shelves



Picture 16: Paternoster lay



4.4 Mapping conclusion

E-commerce is organized as an extension of emergency order picking, an operation that is separated from ordinary warehouse operations. Further, the e-commerce warehouse organization is characterized by temporarily convenience. Several procedures are in place to allow product distribution, but there is a general consensus that these solutions are far from optimal. As the sales volume in this channel is expected to increase, the e-commerce emergency order procedure may become less viable. E-commerce sales are affecting current operations by reallocation of resources and consumption of space and time. This is especially applicable in the emergency orders handling. Also, e-commerce has priority

before ordinary orders. This latter argument follows as e-commerce is set up as an individual emergency order queue.

We have identified that the e-commerce solution faces multiple problems. For instance, it is not possible to know where the products are located under shipment. This is a consequence of how e-commerce orders are received and how the systems talk to each other at ML and the dealers. The system integration between the ordinary and the e-commerce flow has also forced several other unwanted solutions. This includes the semi-manual batch-converting procedure, especially applicable for products that do not fit in the available packaging.

Overall, the current way of warehouse operation organization is allowing ML to meet the customer's expectations. This also holds true for the separation of ordinary, e-commerce and emergency order queues. With the current volumes, it is sensible to allocate two employees to the e-commerce and emergency order area. Low order volumes in the e-commerce queue allow flexible allocation of personnel to the emergency queue when needed. Still, e-commerce orders restrict capacity in the emergency order queue. By increasing e-commerce volumes, the capacity in the packing corner is in need of consolidation. The packing table used in both e-commerce and emergency operations can be overstocked in situations when demand is high. Also, when demand is high for emergency orders, there may occur an element of stress, since the two employees in this queue also handles e-commerce. Thus the area itself is seen as a bottleneck for larger order volumes. As the sales volume in e-commerce is expected to increase, the current organization will become less viable. Therefore, to successfully prepare for the future, re-configurations are necessary.

5.0 E-commerce

In addition to ML's dealer sales channel that targets professionals (the dealers, franchises and self-owned), ML has established an e-commerce sales channel targeting private customers. The sales channel is a response to increased competition in the market where actors such as Komplet group, Biltema Norge AS and GS Bildeler have developed and launched e-commerce solutions of their own. In the car industry, third party actors are able and allowed to sell and distribute spare parts and accessories for other car brands. These products are commonly denoted "third party products". As these products can be seen as substitutes from the originals, ML has felt the need of easing the access of their own product range. A competitive advantage for ML is that they are the only distributor of original spare parts for the car brands Audi, Volkswagen and Skoda. However, the current e-commerce solution at ML focuses exclusively at selling car accessories and otherwise products that require low technical expertise to install. Examples of the products range from coffee mugs through rubber mats and car rims.

5.1 E-commerce orders and sales

MGs e-commerce platform was launched in March 2012. From 544.000 in revenue the first year, to 2,9 MNOK in revenue in 2015, the e-commerce platform experiences growth. The e-commerce solution is, internally, considered a strategic priority, with a large potential. The historic growth is visualized in the below graph. Data points are showing monthly revenue from conception of the platform march 2012 until February 2016.

Figure 8: Turnover

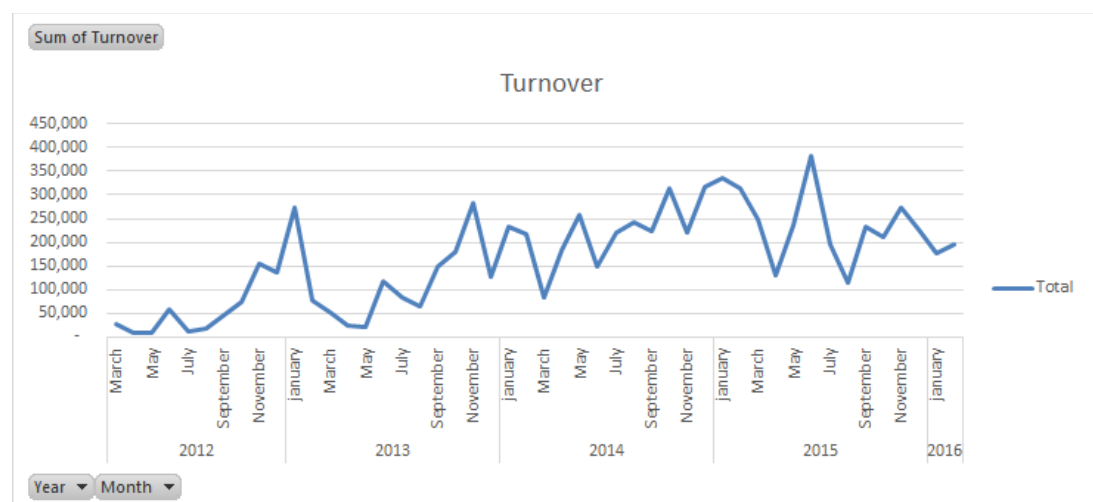
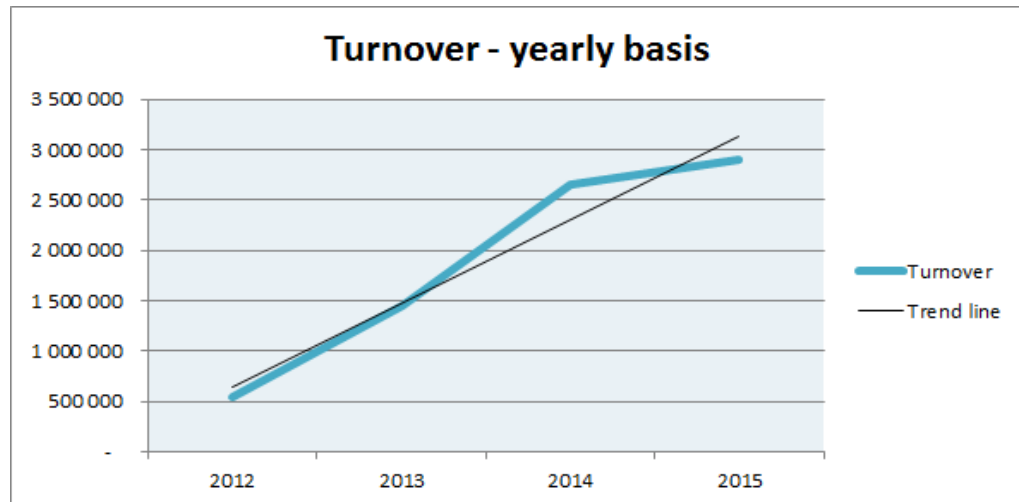


Figure 9: Turnover



There is a broad variation in demand over a year, but the trend is clearly visible by the inserted trend line: There is growth. The order history confirms that both average order size per month and number of orders increases on average. This is supported by the two following illustrations, showing average order size in NOK per month, and number of orders per month.

Figure 10: Average order size

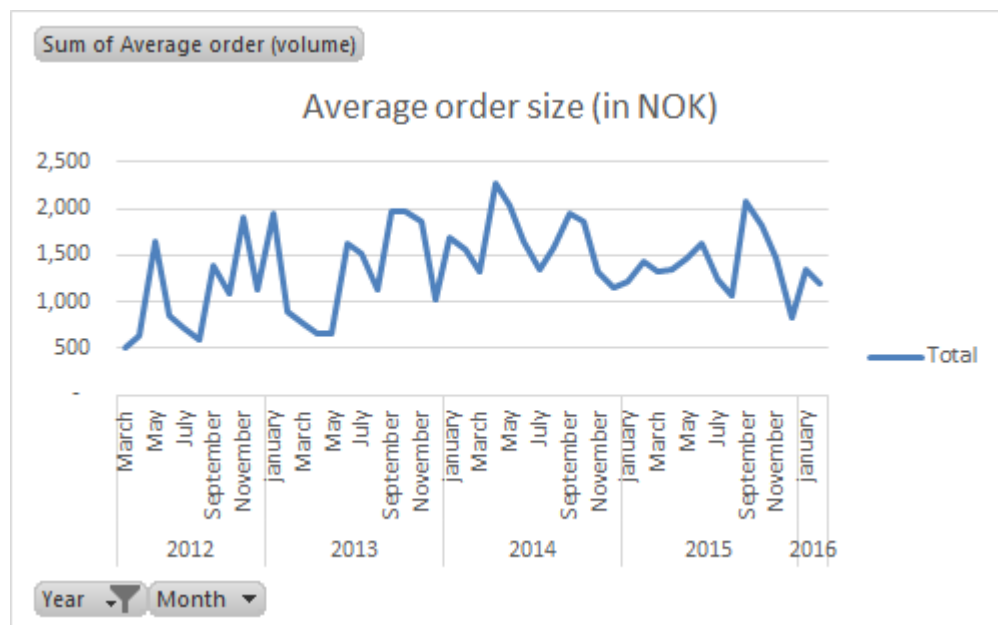
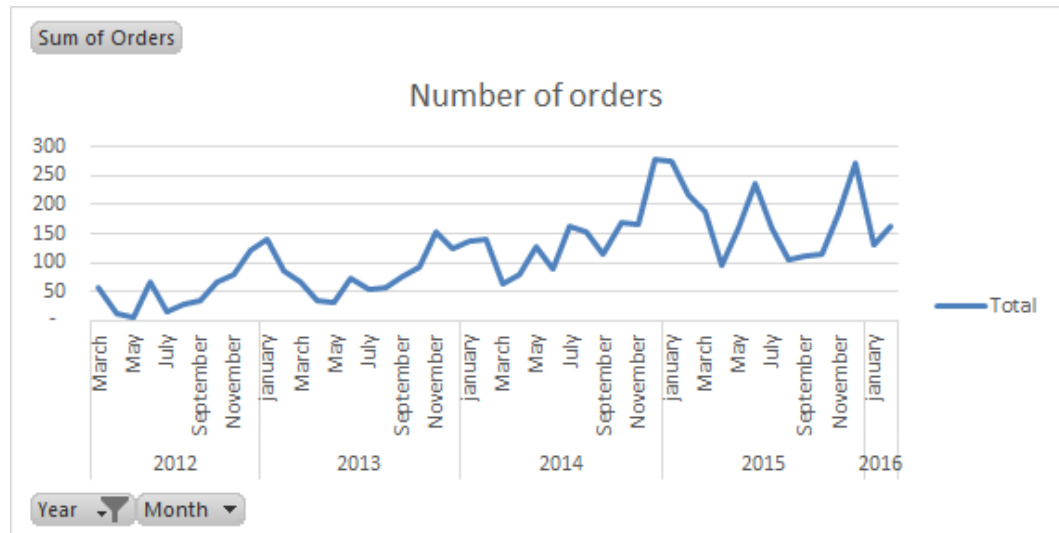


Figure 11: Number of orders



Currently, all the products available in the e-stores are also available for the dealers. Only 6.5% of the total sale of these products (accessories) is generated from the e-stores, and 93.5% of the e-commerce available products are sold through the dealers. The remaining 6.5% share is not considered as additional income, but more as an additional service ML offer to the customers in order to increase service level, and customer value.

5.1.1 E-commerce in the future

MG states that e-commerce is a focus area with high priority. The group wants to grow on e-commerce, and have launched actions in order to reach this desire. MG are currently working under the conditions of a 400% increase in 2016, which implies a total volume of 11,6 MNOK by end 2016. This indicates further growth, and a careful medium to long-term goal is to turnover 10 times today's numbers, equal to approximately 29 MNOK. The more high-hanging goal is however to reach 50 MNOK in revenue. Important milestones for reaching the target are to double the number of visiting people in the stores, and simultaneously increase the conversion rate to 1%. Current averages show that 24.400 people visit the stores every month. To double these numbers indicates 48.800 visitors per month. An increased conversion rate to 1% with doubled visiting numbers result in 488 orders per month, and with an average order size of 1.404 NOK, result in 685.000 NOK monthly revenue, accumulated to 8.222.000 NOK on yearly basis. In addition, organic growth is expected to contribute 60% of increased sales. For the remainder, ML has hired a PR-agency to help them reach the targets. However,

these goals alone are not enough in order to reach the overarching turnover goal toward 50 MNOK, even 100 MNOK on a long-term horizon.

The current product portfolio consists of products without the need of expert competencies or fitting by professionals. However, in order to reach the long-term goals, one strategy is to increase the product portfolio to also include spare parts. This is a topic discussed with ML's head of e-commerce, which ML investigate as a future action. As the current setting is, all products available by e-commerce have to be located at the warehouse. The exception is for products ordered by some of ML's third party vendors. This is due to the lead time ML faces from its suppliers. If the product assortment is expanded, cross docking may be a necessary solution in order to make quick response and deliveries in order to handle increased variation in product demand. This also leads to requirements for changing how to handle outgoing logistics due to shifts in products types. For instance, there are stricter requirements for handling of engine parts (spare part) than rubber mats (accessory). However, the discussion and effects of an increased product portfolio are kept outside this master thesis.

The described different turnover goals lay the foundation for simulating different scenarios. Scenarios combined with different warehouse configurations are able to look at the warehouse implications on costs and profitability of different turnover volumes. See section 8.2 for simulations.

5.2 Current setting of ML's e-commerce solution

Currently, MG has three separate websites for each of their online-stores. Each e-store corresponds to the brands Volkswagen, Skoda and Audi respectively. The e-stores are entities on their own with a separated digital inventory, but follow the same modular build and design in accordance with IBM WebSphere commerce. The following section will cover the organization of MGs e-commerce sales channels, their organization and which administrative processes and activities that is generated from e-commerce sales.

To place an order, it is required that the customers pay upfront by credit card. When the payment is confirmed by Nets, the order is placed at Astro and thereby confirmed at ML for picking and packing. Customers can order products from

third party suppliers through ML's e-stores. These products are always registered as in stock. However, if the customer orders such products and they are out of stock at ML, the administration of ML has to place an order manually. Third party products are shipped directly to the dealers and the supplier is responsible for delivery. Generally, customers can choose between home deliveries and pick up at dealer stores. Home delivery costs 69 NOK, 99 NOK or 179 NOK based on weight of the order. For third party deliveries the alternative of home delivery is not an option as this will cause products to be sent in two separate shipments.

Customer order placement is spread over the day. If the ordered product is in storage, the order is automatically placed in the order queue system at ML. The warehouse operations generated from the customer order are described in the section 4.2.3.1 e-commerce picking and 4.2.4.1 e-commerce packing. After picking and packing, the order is closed in Astro, and the order status is changed to "sent". The system automatically generates a sending confirmation, which is sent to the customer. In reality, the order is packed, but not yet shipped at this stage. E-commerce orders are registered as shipped when the packing process is completed at ML. As a result, it is up to the dealers to have a system or routines to handle the final step of the delivery to end customers who have chosen the option of pick up at the dealers free of freight expenses. To ensure correct deliveries, the e-commerce department sends an email containing e-commerce orders and corresponding customer information to the relevant dealer that is in charge of customer pick up. Optimally, the dealer calls the customer to inform that their order is ready to be picked up. One problem in this setting is that the customer's phone number is not visually represented on the parcel note, that is the note labeled on the parcel or products, even though the customers has to insert phone number when ordering online. The majority of inconsistencies and challenges are attributed to system integration between Møller Netts M-lager and Astro and otherwise lack of customizable options.

The e-stores product lists exclusively contain SKUs that do not need fitting by dealers or expert competence, which are product listed as accessories. If the customers want technical or mechanical products, they are encouraged to contact the dealers. Customers tend to place orders of one product. This makes ML vulnerable for stock out situations. ML experiences a converting rate of 0,6-1,6 %.

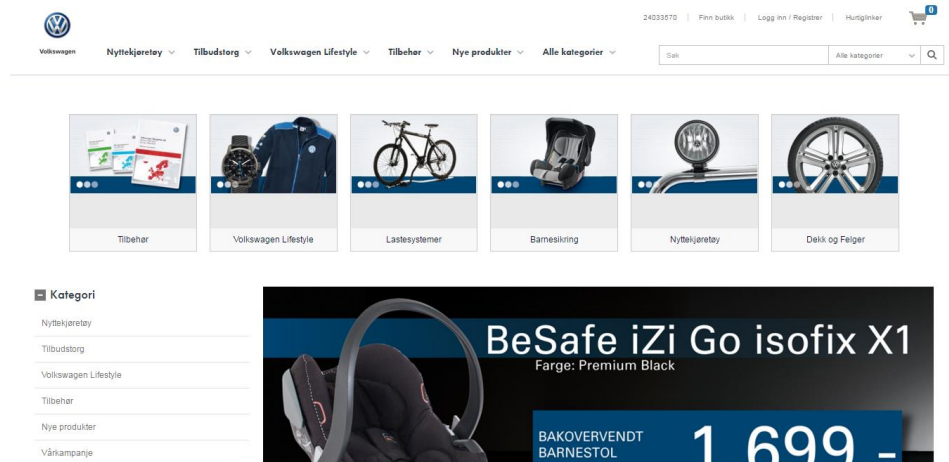
They believe this is because many people use the e-stores as encyclopedia, or to compare prices at the dealer. The prices in the e-stores are adjusted to be similar with prices at dealers in the Oslo area. This pricing scheme in itself poses several considerations. Firstly, the current approach ensures that the e-commerce customers face the cheapest price available for products delivered by ML. A consequence of this may be that customers that uses the e-shop as an online product encyclopedia and chooses to visit stores outside of the Oslo region face higher prices than originally anticipated. Prices generally differ according to region because higher transportation costs are applied to the dealers purchasing costs. Such differences in price may be difficult to communicate with customers and provides an incentive to ipsatively choose the online sales channel rather than the dealer. This could prove to affect the relationship between ML and their dealer network and may ultimately provide dealers with negative incentives for handling e-commerce orders. However, as e-commerce is a strategic focus area at ML, the price mechanism is an important factor to consider. Growth may be stimulated by keeping the price mechanic incentive in place. Still, this tradeoff should be thoroughly considered and discussed with the appropriate stakeholders.

5.3 E-stores

The design of Volkswagenbutikken, Audibutikken and Skodabutiken are similar, because they are all built using the same base platform with the similar functionalities and user interface, both back-end and front-end. The screenshots below shows the online organization of the website. The store is organized with different product categories based on product type. Every category has sub-categories for more detailed segmentation and navigation. The site mainly utilizes “point and click” to navigate. Additionally, a search function is available for customers looking for something particular. Support functionalities are built up as other e-stores, where you can register your own user account, contact support, locate the nearest dealer, etc. Every product is supplemented with a short description and often several pictures, consistent with Bring (2015) “choice of online store” considerations, and the price of the product. Some products also have different attributes, where options such as choosing color or size are found.

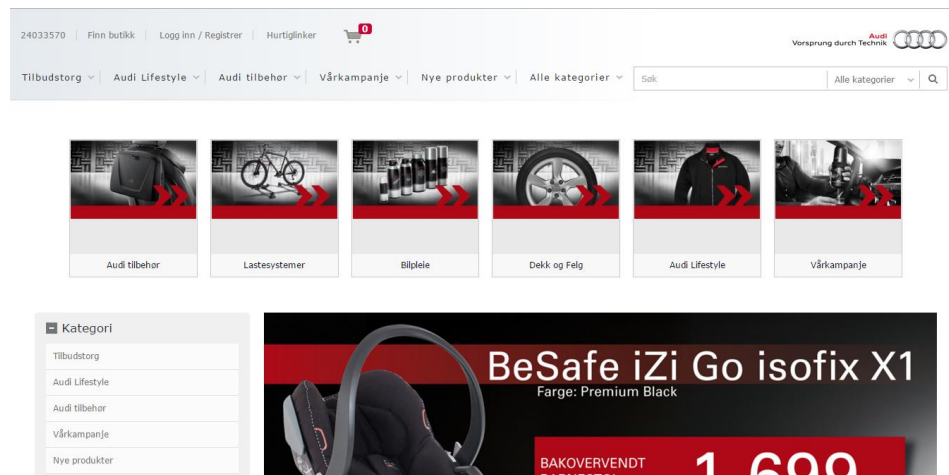
The design of the stores is exemplified below with screenshots of the main page.

Picture 17: Volkswagenbutikken



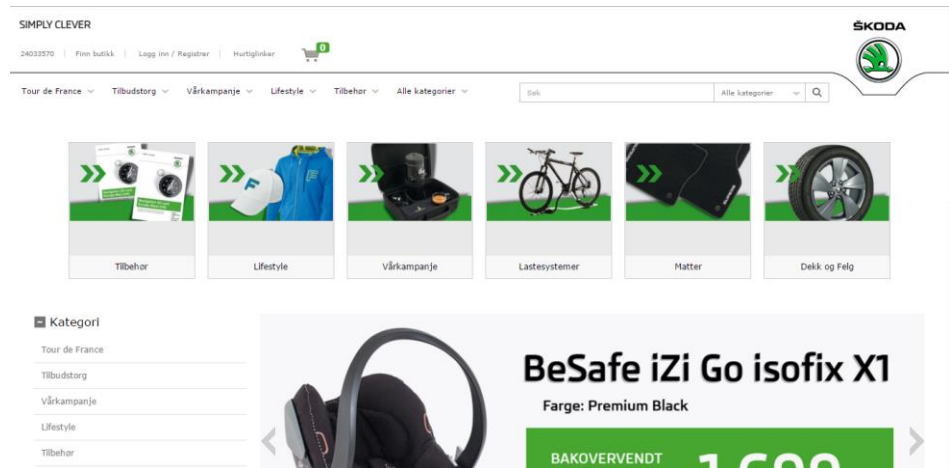
Source: Møller Bil (2016b)

Picture 18: Audibutikken



Source: Møller Bil (2016a)

Picture 19: Skodabutikken



Source (Møller Bil 2016b)

5.3.1 Challenges with the e-stores

Comparable with brick and mortar stores, e-stores require coordination of activities and allocation of resources. There are however several differences regarding the operations of tasks between these two sales channels. One notable contrast is found in the fact that e-stores do not require the same security as physical stores. Brick and mortar stores require closing to counteract theft or avoid higher variable costs because of having employees present through the night. This situation is almost entirely avoided through an e-commerce sales channel. Instead, there are other challenges that require attention. According to DeLone and McLean (2004) information system success (i.e. e-commerce) consists of six interrelated dimensions. Among these, quality of systems, information and service are emphasized along with usage, user satisfaction and net benefits. A particular example includes updating products listings with correct prices, pictures and descriptions. The store itself needs to be designed appropriately to ease the purchasing process for customers. Product articles should be structured systematically and in sum, the total experience should be regarded as convenient. In the following, we have identified some challenges with the three e-stores controlled by MG.

In order to address stock out ratio, an inspection of product availability has been undertaken. A sample of 88 products was selected from the VW e-store in order to return a margin of error on 10% on a 95% confidence level (Newbold, Carlson and Thorne 2010). The sample revealed that an average of 40% of the current e-stock is listed as “out of stock”, and impossible to buy, order or reserve for the customers. In reality, the products may actually be in stock, but due to small changes in packaging, the product may be registered with another SKU number. The e-commerce system (consisting of multiple components) is not updated automatically with new information and as a result the storage value uses expired data. To fix these technical issues, more IT-resources are needed. The IT-resources required are likely to exist within the MG, but e-commerce lacks the internal hierarchical position to allocate all necessary resources. In industries where ad-hoc situations occur constantly, access to key resources is not always possible. One example is the “diesel case”, which resulted in reallocation of IT-resources, while putting other projects on temporary hold.

There are also several inconsistencies, inconveniences and errors related to the site functionality in itself. As an example, when navigating back and forward between pages in the product segmentation and clicking on a product, users are restricted from re-entering a previously visited page. In addition, it is in general difficult to navigate between the different product segmentations. The homepage has three navigation solutions that offer the same functionality, which makes the page less intuitive to use. For example in the Skoda store, by clicking accessories (tilbehør), the display shows 622 products, but by clicking next page, only 214 products are displayed. Additionally, when trying to access the last page, only 12 products are displayed. As a result, the site navigation can be experienced as frustrating for the customers. This latter point may be one of the factors affecting the conversion rate, which on average were 0.68% of browsing customers the last year. There are also several issues on a more detailed level. For example when users are selecting a product with different attributes, they are in some situations unable to choose some attributes, as a result the specified product cannot be bought. We have identified some products that lack pricing. The side effect is that customers are unable to buy the product. Additionally, some products are just not possible to buy, due to error messages like “not available”. As a final bug, we also received an error message that popped up during our browsing which stopped the session. (“Det har dessverre oppstått en uventet feil. Vennligst forsøk igjen senere. Hvis problemet vedvarer, ta kontakt med kundeservice.” 01.03.2016).

5.4 E-commerce conclusion

ML's e-commerce sales channel is designed for targeting private customers through access of original VW, Audi and Skoda products. ML's sales generated from the e-commerce channel are increasing, but organic growth is not enough on its own to reach the immediate target of 400% growth. To reach this target, it may be preferable to sort out several of the systemic inconsistencies between Møller Netts M-lager and Astro. One example in this regard is that the e-commerce department must spend time to send correct customer information to the dealers. Additionally, it may be beneficial to investigate and correct the technical issues related to the e-stores. To enable this progress, appropriate IT-resources should be allocated to the task. Technical issues may negatively affect customers to sales-order conversion. In order to reach the goals of doubling number of visitors and improved conversion rate, overall quality options should be considered. In the

simulations that follow in section 8, we assume that the conditions to run e-commerce stores are solved. In other words, we disregard the technical IT challenges, and assume that the e-stores itself is running smoothly.

6.0 Comparative analysis foundation - Komplet Group

This section provides the foundation of a comparative analysis between ML's warehouse organization, and one other actor's warehouse operations. In order to learn and obtain inspiration, we wanted to reach out to a perceived best in class e-commerce actor. ML requested that this actor could be the Komplet Group.

6.1 Introduction to Komplet Group

The Komplet Group identifies itself as a "leading European e-commerce actor" (Komplet Group 2016). In total, the group runs 16 online stores, with products ranging from electronic hardware, baby equipment, and car parts to an online pharmacy. The total product portfolio available in stock consist of more than 38.000 unique articles. The group had a total revenue of 7.3 BNOK in 2015, all generated from e-commerce. To handle these volumes, Komplet has employed a workforce of approximately 800 people (Komplet Group 2016). Additionally, Komplet Group has been one of the first companies in Norway that have utilized the fully automatic standardized logistics technology Autostore. As Komplet and transportation is the only link between producer and end customer, the logistics and deliveries are seen as key issues and thereby a source of competitive advantages. The Komplet Group's main competitive advantages are perceived as quick delivery and high level of customer service. In general, it takes approximately three hours from order placement at the e-store until the order is available for pick up at the warehouse in Sandefjord. For home delivery, orders are distributed by Postnord Logistics and are received within one to three days for all locations in Norway. The enabling factor for the quick delivery can be attributed largely to Komplet's own internal logistics handling and the cross-docking function delivered by Postnord logistics. Because of the size of e-commerce operations conjoined with the state of the art technological warehouse investments, the Komplet Group is viewed as a suitable actor for a comparative analysis.

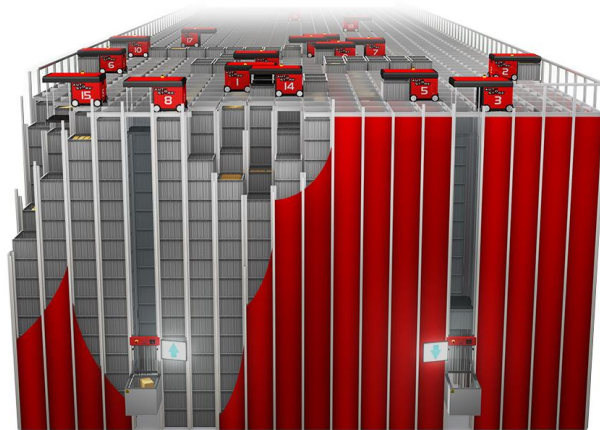
6.2 Autostore

The Komplet Group has historically had contact with the Hatteland Group, the developer of the Autostore system. This in conjunction with the "geeky" profile of The Komplet Group was a factor for choosing Autostore. In order to continue their operations in Norway, The Komplet Group decided to invest in a new

system for handling of internal logistics. The system was fully implemented as the core of the warehouse by 2007.

The robotic design is comparable to small cars with the same size as the shelf dimensionality. Orders are received by wireless communication from the control system. Each robot is able to pick a bin up to the same size and dimensionality as itself with a total weight of 35 kg by utilizing an integrated lift. Bin height is available either in 220 mm or 330 mm, and bins can be fitted with compartments to store different product categories. Bin length and width are respectively 62 cm and 45 cm whereas the internal measurements are 40 cm wide, 60 cm long and 31 cm height (MWPVL International Inc. 2016). All robots are able to move at a speed of 25-30 km/h. The storage system is designed as a modular rack area. All storing and picking are conducted using a rail system, running in x and y directions, at the top of the grid. This effectively utilizes floor space that would otherwise be used for picking personnel and trucks. To access products that are located below the surface, the robots must dig out bins until they reach the one intended by the system. This digging process takes more time the higher the rack. Additionally, there are no designated temporary storage areas for dug up bins. Thus, the robots temporarily place each of the dug up bins on the top of another modular storage rack. The bins are then transported to ports. The same ports can be utilized as the input area for storage of new products. The ports themselves are delivered in two modules, either as conveyor port or carousel port. The conveyor port is able to handle a maximum of 240 bins per hour. This is in total for both inbound and outbound logistics. The carousel port is able to handle a total of 500 bins per hour with its three rotating arms (Hatteland 2016). When installing Autostore, an additional area for maintenance and repair is needed. The required size of this area depends on the number of robots used.

Picture 20: The Autostore Cube



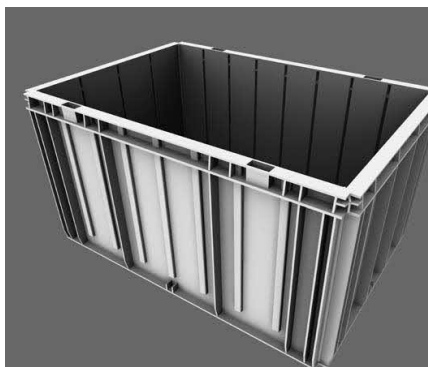
Source: Hatteland (2016)

Picture 21: The Autostore Cube



Source: MWPVL International Inc. (2016)

Picture 22: The bin



Source: MWPVL International Inc. (2016)

Picture 23: The robot



6.3 Warehouse operations at The Komplet Group

The order process at The Komplet Group starts when a customer places an order in one of the group's web-stores. The customer order moves into an enterprise resource planning (ERP) system, and the customer receives an order confirmation by mail. Picking assignment is generated from the ERP system to the warehouse management system. Simultaneously, messages move from the warehouse management system to the ERP system in order to update order status and availability. An EDI-message is further generated from the ERP-system to the transportation company. The EDI software can distribute sending confirmation with tracking link to the customers, providing the customers with increased customer service. The Komplet Group has organized their warehouse operations in two main segments; automatic and manual handling. All orders compatible with the Autostore system automatically generate picking orders for the robots. This process is done within seconds. Then employees receive the products from the robots, and pack the products for further internal logistical handling and final shipping. The picking and packing is done manually for product segments that are too large and otherwise unable to fit in the Autostore system (“uglies”). The transporting company delivers the package to the designated pick-up-point. The customer subsequently receives an SMS or e-mail, and the package is ready to be picked up by the end customer (Qvale 2013).

6.3.1 Receiving and storing at The Komplet Group

Receiving is organized with delivery ports straight into the warehouse. The Komplet Group receives mostly pallets from its suppliers. The pallets are manually controlled, and placed for storing using a hand pallet truck. Overstock is stored in racks and shelves directly on the pallet in heights, along with products too large to fit in the Autostore bin system. Products suitable for Autostore utilizations are stored in the Autostore bins. In order to reach the bins, employees manually split the pallets, and put products in bins. The employees can move minimally from the workstation by throwing empty cardboard boxes on a conveyer belt over the storing workstation. This is consistent with the lean philosophy of eliminating non-value adding activities, here represented as time (Tangenes and Gjønnnes 2013). It is important that the Autostore software system and warehouse management system is aware of which products are placed in

which bins. As long as this is correctly handled, the Autostore robots place the bins for storing automatically.

6.3.2 Picking at The Komplet Group - Autostore

Of the total 28.000 m² warehouse at Komplet, Autostore accounts for 2.800 m². Rack height is approximately 6 meter and there are 75 automatic robotic pickers. In total, there are approximately 72.500 bins. Picking orders are automatically generated when the orders are placed at the Komplet Group's e-stores. At any time, there are approximately 800-1.200 picking assignments pending in the system. The robot then retrieves the product and moves it to a port. The Komplet Group utilizes both the conveyor and carousel port. The retrieving end of the port location is organized as a workstation with a designated employee. The employees are responsible for consolidating and re-packing orders. The bins placed in the Autostore system are virtually inaccessible by employees by other means than through the system. This adds to security but also reduces picking and storing flexibility. Additionally, the control system automatically generates commands that tell the robots to recharge whenever needed. In cases of idle time, the robots automatically sorts shelf locations so that the most frequently sold products are placed closest to a direct picking location (Ludt 2015).

The bins are standardized plastic containers and are identified by a unique number stored in the controller database. Some bins are compartmentalized with either plastic or cardboard walls fitted at the inside of the bin. The bins size and weight limit is a constraint in the system. All product categories that fail the requirement of fitting three units in the bin, are stored as "uglies" and are directed to the manual storage area.

Picture 24: Autorstore at The Komplet Group



6.3.3 Packing at The Komplet Group

The Komplet Group uses both single conveyor ports and carousel ports in the transition between picking and packing. In the single port solution, the robots are locked to hold the bins while employees handle the products. The carousel solution allows the robot to place the bins, and then leave for other assignments while the employee relocates the products from the bin to packing according to the customer order. All work stations are placed in proximity to two parallel conveyor belts. The second level of the belt contains constant cardboard box supply, generated from a machine that automatically folds suitable cardboard boxes. The cardboard boxes are in turn used for packaging the outbound products. The lower level of the conveyor belt is utilized as transportation for packed products. There are primarily two sizes of cardboard boxes and all contain plastic sheets utilized for securing the products. Packing employees relocate products from the Autorstore bins and to the cardboard boxes. The plastic at the inside of the cardboard boxes are overlaid at the top of the products. As orders are picked, Autorstore automatically generates a package label. This label is attached, by an employee, at the side of the box to allow an automatic scanning process further in the outbound logistics operations. Finally, the employees place the product-containing cardboard box on a conveyor belt. The conveyor belt serves as the main facilitator of the remaining in-house logistics operations. The boxes transition through a hot air machine, which melts the plastic over the products and thus secures them to the cardboard box. Other machines are utilized to attach the top of the cardboard box and attach the final freight notice.

Picture 25: Picking from bins



Source: Vindegg (2016)

Picture 26: Conveyor belts



Source: Vindegg (2016)

6.3.4 Shipping at The Komplet Group

When the packing operation ends, it transitions directly into shipping. An extension of the previously mentioned and used conveyor belt is utilized to directly place products inside of an outbound transportation truck. Manual labor is however necessary in order to relocate packed orders from the conveyor belts to the inside of the trucks. Trucks are utilized as a part of The Komplet Group's delivery strategy of reaching private customers at, or close to, their home location. The Komplet Group has selected Postnord Logistics as their main provider of transportation and distribution. In addition to delivery, Postnord provides cross docking of entire orders and are thus able to conjoin shipments that require more than one box to be fulfilled. The picture below shows the conveyor belts utilized at Komplet that transports products packed in cardboard boxes directly into the trucks for rapid loading.

Picture 27: Conveyer belt directly into the truck



Source: Vindegg (2016)

6.3.5 Manual warehouse operations at The Komplet Group

Due to product size and other product characteristics, such as shape and weight, some products are unable to fit within the restricted Autostore bin-size. This leads

to a requirement of maintaining man-to-location processes and thereby traditional shelves and racks for storing and retrieving. However, in order to keep the manual picking operations as efficient as possible, all products for picking are stored in the lower area of the shelves. This lead to no requirement for lift trucks in the manual picking operation, and the result is high picking speed. Overstock products are stored at the higher racks locations and lifted to the ground level when it is necessary to replace or refill the current parcel or container.

6.4 Reflections

The Komplet Group predefined a criterion of at least three products per bin. This is being challenged as recent experience shows indications that it will be more efficient to store all products that fit with the Autostore bin dimensions, regardless of numbers. As a consequence, the Autostore system could be a viable option for all products that are able to fit and are not otherwise constrained by weight limits.

All picking operations and internal transportation happens without human interference. The Komplet Group has successfully eliminated most of the manual processes, and the result is high efficiency, high service level, and minimal damage and picking errors. Because of the order picking assignment size, the Autostore system is able to optimize picking routes efficiently. Here, customer orders are picked in accordance with bin placement in the system. When a human workforce is involved, there are multiple installations in place to ensure swift and steady process execution.

In order to efficiently implement Autostore to current and new products, product dimensions are crucial. In The Komplet Group's case, the packaged products are logged as system data for freight purposes. The Komplet Group partly receives these product dimensions from their suppliers, and partly measure products themselves. Both weight and measurements are listed in their database. Weight and size information is utilized for costs and prices regarding shipping. New products The Komplet Group adds to their product portfolio are control-measured during first time arrival.

Prior to the Autostore investment, the operational time from order to package was approximately two hours. Today however, processing time may be as low as 8

minutes. The manual labor left for employees lies in picking up products from the bin and prepare them for further processing. Similarly, the employees are needed when goods are stored.

6.5 The Komplet Group conclusion

During our visit at The Komplet Group's warehouse in Sandefjord, it was revealed that The Komplet Group utilizes the Autostore warehouse system as the core of warehouse management processes. The Komplet Group's business emerged in the e-commerce segment, and is specialized to handle e-commerce generated activities. Their core of business is e-commerce activities, and handling of these. They are specialized in meeting customer expectations. For example, the weight and product dimensionality data The Komplet Group collects allows them to store products in the appropriate location and in correct quantities and allows specific price information regarding shipments. EDI-technology, enable tracking opportunities of all shipments and is thus meeting customers expectation on this regard.

There have been multiple large investments in machinery, which has reduced the need of manual processes while simultaneously increasing the need of product standardization. This allows The Komplet Group to execute operations swiftly and with few errors. The system utilizes storing space efficiently and allows storage of larger products at more accessible picking locations. The Autostore system creates economies of scale through serving all the different online stores The Komplet Group runs. Completely new product segments and new store concepts are able to utilize the economies of scales generated by the system as long as the products fit with the standardized weight and dimensionality restrictions. Hence, Autostore can be regarded as a strategic decision, which forms future growth possibilities. Thus, it is identified that The Komplet Group has managed to leverage their strategic investment to secure economics of scale throughout multiple store brands and customer segments.

7.0 Comparative analysis of Møller Logistikk and The Komplett Group

The goal with this section is to discuss the mapping of ML's warehouse operations against the overview of The Komplett Group's warehouse operations. The aim is to identify similarities and differences, and eventually achieve key learning points for re-configurations at ML. It is worth mentioning that the nature of the two actors business is different, even though elements of their business are similar.

7.1 Comparative analysis

Similar warehouse operation structures are present at both corporations. Both actors have receiving, storing, picking, packing and shipping as their working pattern and warehouse operations. The differences lie in the design, configuration and organization of these operations and underlying processes. At ML the prevalent organizational feature is man-to-location orientation. At The Komplett Group the process orientation can be regarded as location-to-man. ML utilizes forklift-trucks and custom cars to handle warehouse internal transportation. The Komplett Group instead uses conveyor belts, which frees up human resources and reduces errors.

The most similar operation between the two actors is found in the receiving operation. Even though ML partly receives goods by train, receiving is labor intensive and require manual handling and thus confirms the findings by Koster, Le-Duc and Roodbergen (2007). The storing operation in total is also partly similar. There are no direct contrasts for storage of large products as both actors rely on manpower and transportation equipment for placing the goods at the appropriate location. In general, both actors utilize manpower to perform all receiving activities, which are connected to storage. At The Komplett Group, the manual labor ends when the product is transported to an Autostore port location, registered and placed in a bin. The storage operation could therefore be regarded as partially automated. This process can be evaluated against ML's storing of small products in the paternoster. Here, good are transported to the machinery where they in turn are registered and placed in an appropriate position.

One of the greatest reasons for the differences in warehouse layout is the nature of distribution and demand. ML utilizes their already designed delivery structure, by offering delivery at the dealers. ML also need to handle home-delivery, and uses Bring as transportation partner. The home-delivery option is less used by the customer's, corresponding to 21% of the online customers. Resultingly, all home deliveries are placed in the postal cage for further handling by Bring. As a result of this, ML faces less points of delivery than The Komplet Group. Because The Komplet Group offers home-delivery, and has a large customer portfolio consisting of around 1,8 million unique customers with different points of delivery, The Komplet Group fills up several full truckloads every day. As Postnord Logistics handle the cross docking, The Komplet Group's shipping operation can be regarded as completed after products are placed in the trucks. At The Komplet Group, the consolidation of different parcels happens at the transporters terminal. If one customer places an order for several products, the total sending has only one sending number, and different parcels identities. The different products are picked separately, and consolidated by the transporter. As a result, all products in the order are loaded on the same distribution truck and delivered together to the customer. This is given that all products in the customer order is available in stock. While at ML, the dealer delivered orders are consolidated and sorted at ML's packing area.

Table 3: Summary of comparison

Operations	Møller Logistics	Komplet Group
Receiving	Manual - truck/train	Manual - truck
Storing	Manual	Semi-manual
Picking	Manual	Automatic - Autostore
Packing	Manual	Semi-automatic - conveyor belts with manual input
Shipping	Manual - with help from transporter	Semi-automatic - conveyor belts with manual input

7.2 Discussion - differences and similarities in warehouse operations - what did we learn?

It is possible to organize the warehouse layout based on dimensions of the products. For example use paternoster/Autostore for small products, Autostore for medium size products, and traditional racks for large products. Autostore is ideal to handle medium size products. With correct compartmentalization of bins, Autostore can also store small products efficient.

In both warehouses, space (most of all floor space) is regarded as the bottleneck. Because of this, it is increasingly important to manage this space wisely. During our visit at The Komplet Group, they described that the limitations regarding space can be interpreted advantageous on the short term, in the sense that it forces the management to prioritize the item slots available. Still, as the Autostore system has been implemented, there is now more floor space available at The Komplet Group. It is this fact that creates the possibility of storing larger products at the floor position, which again reduces the average picking time. For ML, the areal is seen as a constraint, and especially the packing zone for emergency and e-commerce packing is organized with several extensions. These include the temporary storage of scooters, mobile racks and otherwise items without a permanent position. In sum the ML packaging area can be regarded as a miscellaneous zone with several intertwined processes.

The packing process at the two companies are conceptually different in the sense that ML's primary organizational structure revolves around work zones where the employees assigned to the particular picking queue are responsible for all operations up until shipping. For The Komplet Group, packing with its primary resource of manpower is organized as a workstation with one employee assigned to every conveyor and carousel port.

Between the two observed actors there seems to be a commonality in that the picking organization greatly affect the organization of packing and shipping. As a general conclusion we find it indicative that the warehouse operations can be regarded as a two-step procedure: From receiving to storing and from picking through packing and to shipping.

7.3 Reconfiguration at Møller Logistics

A calculation has been made by using shelf and storage type information to compute the total utilization of cubic meters. The result of the calculation showed that approximately 1% of the utilized shelf space could be converted to an Autostore storage system. However, the Autostore storage policy adopted at The Komplet Group showed that the storage bins were efficient for storing quantities as small as three. Several of the shelves that were filtered from the computation contain products that would fit in an Autostore system. The majority of these are not included in the calculation, as the shelf dimensionality does not fit with the restrictions set. The restrictions are in turn set to eliminate speculation regarding shelf customization and as a result the calculation returns the absolute minimum possible conversion. In conclusion, a valid computation of possible Autostore conversion can hardly be done without knowing dimensionality of products. To the best of our knowledge, this feature is currently unobtainable without either resorting to manual counting and registration or without sorting to heavy investments in specialized measuring equipment. Such equipment can include 3D-object scanners.

7.4 Comparison conclusion

Møllers interest in the The Komplet Group is not without substance. The Komplet Group is positioned to be in accordance with modern warehousing systems development. Still, there are large differences between The Komplet Group and ML, which should be considered before a direct comparison is made. One of these is their function of services. ML primarily sells and delivers goods to professional dealers, whereas The Komplet Group delivers primarily to private customers. The order picking specialization is organized in distinctive different ways. Research do not point out specificities regarding best practice of picking and packing, but highlights the need for order picking specialization that fits the organization's situation and need (ref. literature review). Both The Komplet Group and ML have organized the picking operation specifically to execute the remainder of the warehouse operations given their circumstances and environment. Thirdly, ML and The Komplet Group utilize different orientation towards their warehouse processes. At ML, we classify the majority of activities as man-to-location whereas The Komplet Group's warehouse features automatic components.

ML seeks to capitalize on the economies of scales related to their already established internal logistics and transportation network, but wants to offer greater flexibility for private customers through postal services. As a result, ML's separation of the different sales channels is evident through the organization of different warehouse operations. This situation is avoided at The Komplet Group, which utilizes their warehouse to generate economies of scales for different e-store profiles. Still, there are multiple warehouse operations that can be regarded as comparable for the purpose of this master thesis. These are primarily in relation to the adaptation of lean philosophy, system integration and exploitation of economies of scale. If ML is to incorporate some of the automatic features from The Komplet Group, this should be done with considerations of the warehouse as a whole and thereby not restricted to the e-commerce features alone. This will ensure economies of scale throughout the solution. The Komplet Group's integration of EDI for tracking purpose and their product measurements and dimensions allows them to respond to online customers' expectations regarding product tracking during transport and freight pricing. ML currently lacks these features. Product measurements and dimensionalities would contribute to a more precise freight pricing structure and would allow ML to calculate storing capacity in different warehouse systems towards increasing warehouse efficiency.

8.0 The simulation model

Based on the mapping of the current configuration at ML, the analysis of The Komplett Group and the comparative analysis, we have developed a simulation model. The model is able to predict handling costs of salaries, handling time, number of employees needed to handle e-commerce and ultimately estimated results of the e-commerce as an isolated activity. The basis of the model is three different warehouse configurations and five different revenue situations. The model assumes that the e-stores are running smoothly from the technical and design perspective, and considers the warehouse handling and corresponding costs of e-commerce.

The model is developed in Microsoft Excel™ 2010. A picture of the model and the model tabs can be found in attachments 7. Due to the nature of this case, the model is uniquely designed to secure the best fit possible to the ML case.

8.1 Base model: Profitability

The base model is developed in order to calculate profitability in the current e-commerce setting and with the current sales volume generated from e-commerce. The calculation is built using the following fixed costs factors:

- Salary to management.
- Administering of the e-commerce stores and system, including software, upgrades, product management and optimization of solution. This also includes salaries to support and technical staff.
- Marketing and sales promoting activities.

Fixed costs are calculated from salaries directly attributed cost from IT and administration, and finally from marketing expenses through payments to their marketing agency. These costs are considered fixed for any interval of sales and configuration in the model.

The following variable costs are applied, built to vary based on turnover:

- Handling costs/salaries of warehouse activities: This variable is calculated to be 2.24% of sales. The 2.24% factor is calculated based on the yearly handling cost with current volumes, which is based on e-commerce orders

time consumption and salary cost. In this sense, the costs are classified as activity based (Tangenes and Gjønnnes 2013).

- Cost of goods sold: The margin is calculated by comparing sales price and costs of goods on the articles available in the e-stores. The average margin is calculated using a weighted average.
- Cost of using “PostNord Logistics” as transporter: Average transportation cost per order is calculated from a monthly selection of data, and the customer cost is assumed to be the cost facing ML.

Together, the fixed and variable costs sum up to all costs associated with e-commerce, and provides a picture of the current profitability. As the situation is today, with the current e-commerce turnover of 2,9 MNOK and with warehouse processes organized as separated handling, the isolated result generated from e-commerce is negative. The break-even point is right over 11 MNOK, indicating that the fixed costs are at a higher level than the current turnover would accept. As a result, we have identified that the current e-commerce configuration is not profitable when perceiving e-commerce as its own isolated entity. However, ML puts large efforts on growth in the e-commerce segment, and our model is developed in order to organize future e-commerce volumes.

8.1.1 Inputs

In the model, we simulate on three different warehouse configurations:

1. The current configuration - e-commerce as separated queue.
2. Integrated configuration - integrate the e-commerce queue with the ordinary queue.
3. Automatic configuration - Partly implement Autostore for both the e-commerce queue and the ordinary queue.

In order to simulate turnover shifts effects, we used the following variables as model inputs:

- **Margin:** Calculated using datasets generated from Astro and the purchasing system ML uses. We matched costs of goods and dealer prices on article level from two separate files. Our basis is products sold by the e-stores, which are the product segments “equipment” and “other”. “Parts” and “tools” are excluded. The returned values for margins are generated

for every product. However, because there are differences in sales volumes regarding products it is beneficial to calculate the weighted margin on product level. This is done by multiplication of the individual margins with their respective sales in number of products. This product is thereby divided by the total number of goods sold. Each individual weighted margin is thus added together to present the weighted average margin.

- Handling costs in percent of total revenue: The number is a result of average number of order lines, handling time per order and salary costs.
- Handling time per e-order with the current configuration: In cooperation with ML, we calculated the picking time to be 250 seconds per handled e-order, based on a monthly average. However, in order to have comparable and consistent results, we needed to convert this number to order line handling time. On monthly average, 150 orders are received, covering 277 order lines. This is data extracted from Astro, based on all order lines, sorted by the emergency (e-commerce) queue. This gives an order line per order rate of 1,85, which is divided by the order handling time of 250 seconds to reach order line picking time. Packing time is also part of the order handling time. From the empirical data, we have on average 9 e-commerce orders received per day, resulting in 16.6 e-order lines per day. E-orders constitute of 9.2% of the total emergency queue, as 277 order lines of a total of 2,997 order lines in the queue are e-orders. The available working time in the emergency queue is 750 minutes per day, as there are one person working in the queue from 08:00-09:00 and from 14:00-16:30, and two persons between 09:00-14:00, with 30 minutes break each. Of the available time of 750 minutes, 69 minutes (9.2%) are allocated to handle e-commerce orders in the emergency queue. Total e-commerce order handling time is based on these calculations and assumptions. Both total e-commerce order handling time and e-commerce order picking time is then estimated, and e-commerce order packing is calculated as total e-commerce handling time with e-commerce order picking time subtracted.
- Handling time per e-commerce order with the integrated configuration: Picking time per ordinary order line is calculated by ML to be 0.87 minutes. Packing time per ordinary order line is a result of available packing hours per day divided by total number of order lines handled each day. Available packing time is computed using ML's internal map of

resource allocation, which is separated in ordinary queue and emergency queue, in order to have valid time estimates for each queue. In addition, the integrated configuration requires a packaging station for orders delivered by post. This time factor is assumed similar to packaging time for e-commerce orders delivered by postal services in the current configuration, multiplied with the share shipped by postal services. In total, these three numbers give us the total handling time per order line by integrating e-commerce orders with the ordinary order queue.

- Handling time per e-order with automatic configuration: By automating the order handling, the picking process is assumed handled exclusively by robots without human activity. As a result of this, variable picking time costs is assumed to be zero. We are aware that this assumption is a simplification of reality, as electricity, maintenance and abrasion is relevant factors in the real world. For model purpose, picking time per order line is set to 0. However, the total order line handling time is not zero, as a packaging station is needed. Packaging time is calculated based on assumed packaging time in the integrated configuration.
- Number of working days per year: 230 (Skatteetaten 2016).
- Hourly salary: Average salary is used as base cost to add on vacation pay and payroll taxes. This is done in order to calculate total salary cost per minute.
- Number of orders per year: Calculated using average historically order size combined with total revenue. The number is used as a basis for calculating number of orders per day.
- Share shipped by post: This share is found empirically by analyzing the order history generated from February 2016. We assume this is a valid estimate.
- Cost per shipment by Post: Cost average.
- Available working time per day per employee in minutes: 7.5 hour a day result in 450 minutes.

8.1.2 Simulation/Scenario

Using the above mentioned fixed costs (8.1.1), variable costs (8.1.1) and inputs (8.1.2) we calculated e-commerce results, e-commerce handling time, e-commerce handling cost and required number of employees handling e-

commerce, in the below mentioned different revenue scenarios (0-4) and configurations (0-3).

Sales scenarios:

S_i = sales in scenario i , where $i=0, 1, 2, 3, 4$.

$S_0=2,900,000$, $S_1=11,600,600$, $S_2=29,000,000$, $S_3=50,000,000$, $S_4=100,000,000$

- S_0 = Current turnover
- S_1 = Planned turnover (goal for 2016)
- S_2 = Planned turnover (medium time horizon)
- S_3 = Planned turnover (long time horizon)
- S_4 = Planned turnover (perceived potential)
-

Warehouse configuration:

T_n = Handling time in configuration n , where $n=0, 1, 2$

$T_0=4,17$, $T_1=1,36$, $T_2=0,5$

- T_0 = handling time in current configuration
- T_1 = handling time in integrated configuration
- T_2 = handling time in automatic configuration

In the below simulations of scenarios, the sales volume is the only number we change in each setting. The model is built to change outputs based on sales volume scenarios. In the different configurations, handling time is the variable that changes.

8.1.2.1 Simulation one: Current configuration

The first simulation is based on the current configuration at ML.

Table 4: Simulation one

Current setting					
Scenario	0	1	2	3	4
Sales	2 900 000	11 600 000	29 000 000	50 000 000	100 000 000
Time consumed per day (min)	69	277	691	1 192	2 384
Yearly handling cost	64 985	259 941	649 852	1 120 434	2 240 868
Required number of employees per day	1	1	2	3	6
E-commerce result	-1 262 965	55 642	2 692 854	5 875 696	13 453 893

8.1.2.2 Simulation two: Integrated configuration

The second simulation is based on integrating the e-commerce queue with the ordinary queue, in addition to setting up a packing station. This configuration is elaborated in section 9.1.

Table 5: Simulation two

Integrated setting					
Scenario	0	1	2	3	4
Sales	2 900 000	11 600 000	29 000 000	50 000 000	100 000 000
Time consumed per day (min)	23	90	226	390	780
Yearly handling cost	21 249	84 998	212 494	366 370	732 739
Required number of employees per day	1	1	1	1	2
E-commerce result	-1 219 229	230 584	3 130 211	6 629 760	14 962 021

8.1.2.3 Simulation three: Automatic warehouse

The third simulation is based on partial implementation of the Autostore warehouse system. We elaborate on this configuration in section 9.3.

Table 6: Simulation three

Automatic setting					
Scenario	0	1	2	3	4
Sales	2 900 000	11 600 000	29 000 000	50 000 000	100 000 000
Time consumed per day (min)	8	33	82	142	284
Yearly handling cost	7 746	30 984	77 460	133 553	267 105
Required number of employees per day	1	1	1	1	1
E-commerce result	-1 205 726	284 598	3 265 245	6 862 578	15 427 655

8.1.3 Simulations summarized

Table 7: Simulations summarized

Scenario 0 - 2,9 MNOK			
Setting	Current	Integrated	Automatic
Time consumed per day (min)	69	23	8
Yearly handling cost	64 985	21 249	7 746
Required number of employees per day	1	1	1
E-commerce result	-1 262 965	-1 219 229	-1 205 726
Scenario 1 - 11,6 MNOK			
Setting	Current	Integrated	Automatic
Time consumed per day (min)	277	90	33
Yearly handling cost	259 941	84 998	30 984
Required number of employees per day	1	1	1
E-commerce result	55 642	230 584	284 598
Scenario 2 - 29 MNOK			
Setting	Current	Integrated	Automatic
Time consumed per day (min)	691	226	82
Yearly handling cost	649 852	212 494	77 460
Required number of employees per day	2	1	1
E-commerce result	2 692 854	3 130 211	3 265 245
Scenario 3 - 50 MNOK			
Setting	Current	Integrated	Automatic
Time consumed per day (min)	1 192	390	142
Yearly handling cost	1 120 434	366 370	133 553
Required number of employees per day	3	1	1
E-commerce result	5 875 696	6 629 760	6 862 578
Scenario 4 -100 MNOK			
Setting	Current	Integrated	Automatic
Time consumed per day (min)	2 384	780	284
Yearly handling cost	2 240 868	732 739	267 105
Required number of employees per day	6	2	1
E-commerce result	13 453 893	14 962 021	15 427 655

8.2 Model considerations

As Hornby (2000) describes, a model is a simplification of reality. With that statement in mind, our model is an indication of reality. However, there are some model considerations that need further explanation. As a first, the data in the model is collected and gathered from multiple data sources in different time slots. We therefore assume that the different data sources are consistent, and that the selected timeslots are representative for model purposes. Also, excel related data are available in a time series format (Newbold, Carlson and Thorne 2010), but do not directly correspond with each other because of the availability of data in different time periods. The time series material utilized for calculating emergency, e-commerce and ordinary order lines have been over a time-period of one month. Order picking estimates are gathered from the time employees spend in their respective picking queues, and do not account for deviations in employee speeds, and are therefore based on average estimates. As a final consideration, the dataset

used for comparison is extracted from one month of operational services between 18.03.2016 and 19.04.2016. The total order-lines picked amounted to 180.017, where 2.720 are emergency order-lines and 277 are e-commerce order-lines. Our model uses these numbers as foundation for all scenarios testing, and assumes they are representative.

8.3 Simulation conclusion

As one of the goals with the master thesis was to build a model, we were searching for relevant parameters and variables to base our model on. The mapping and the comparison revealed which performance measures we should use in order to obtain a realistic view of this case. The critical value was handling time per order line in each of the different configurations. With this on hand, we were able to build a model including the factors, variables and inputs mentioned in the above sections 8.1.1 and 8.1.2. With the case specific collection of numeric data as the foundation in our model, we were able to simulate different scenarios for expected sales volumes in the future, and discuss the results for the simulations.

The calculation following the current configuration is made in conjunction with data provided and thus reflects the historic result of the operational year 2015. Because of current yearly sales volumes, the e-commerce channel as an isolated entity from the ordinary flow of goods is not profitable. This is further enhanced by the current configuration where the handling cost is more than three times higher than for the comparable ordinary flow. Because the contributive margin of sales is positive, this conclusion will change when sales increases. Still, there are several other considerations to be made when applying a holistic perspective to the analysis of the supply chain. The emergency channel is considered a strategic element in the overall distribution, and currently the employees assigned to the e-commerce channel spend idle time contributing to serving this flow. This procedure is especially helpful when there are too many orders for one person to handle. In the available data, there has not been identified a need of exceeding the allocation of two employees for the emergency flow.

One of the more interesting figures are daily handling time and required level of employees each day. These numbers are varying in the different configurations.

As the current configuration is the most time consuming, we use this as a benchmark for the other configurations. As the model result illustrates, the integrated configuration consumes about 32% of the handling time compared with the current configuration. The automatic configuration consumes 12% of the time used in the integrated configuration. Thus, the automatic configuration will result in the least variable costs in the long run. However, the integrated setting provides considerable time savings, which can be implemented using internal IT-resources without resorting to large infrastructural investments. Also, both the integrated and automatic configuration reveals that the daily costs of operating e-commerce correspond to one employee's daily wage. This holds true for simulations up to the point of well over 50 MNOK. With the automatic setting, only one employee wage is necessary each day in order to take care of all e-commerce handling including the far reaching goal of 100 MNOK.

9.0 Conclusions and suggested reconfigurations of warehouse operations

This section provides specific suggestions in order to prepare warehouse operations to handle increased e-commerce volumes. The suggestions are based on the mapping of current operations at ML, the comparative analysis at The Komplet Group and the simulations. In our suggestions, we assume IT-technical challenges are solvable, and do not provide solutions for how the recommendations are solved from the IT- technical perspective.

9.1 Main recommendation

Today's configuration at ML allows the organization to expand their sales up to a certain sales volume point of approximately 18,874 MNOK without changing the current configuration. However, there will be less idle time in the emergency queue with such volumes, but no new hires are necessary. Exceeding this point of volume will result in new hires and lack of capacity with the current setting. In the light of this, our main suggestion is as follows: Integrate the e-commerce queue with the ordinary queue. This solution will contribute to reduced e-commerce warehouse costs, and is an implementable solution towards securing e-commerce profitability. This recommendation is supported by our simulation, showing reduced costs compared to the current warehouse configuration.

9.1.1 Integration

The overall goal with this recommendation is to eliminate non-value adding e-commerce processes, and thus create a more lean value chain. Integration of the e-commerce queue requires IT-resources in order to reconfigure how Astro allocates and launches order line assignments. We suggest integrating the e-commerce queue with the ordinary queue, and keep the emergency queue as it is today. The emergency order queue is considered a strategic customer service, allowing time-sensitive deliveries. Although the service requires more resources compared to the other queues, as it is necessary to keep it separated to guarantee high service level and timely throughput.

The integration involves sorting all picking assignments, both e-commerce and ordinary, based on dealer box destination. By performing the integration, several non-value adding processes in the e-commerce queue are eliminated. Examples

are the elimination of separated picking tours for e-commerce, separated packing for e-commerce and dedicated employee handling. This is resulting in time savings and thus cost savings. Subsequently, we confirm the initial assumptions regarding travel time, extracted from Bartholdi and Hackman (2011). Currently, both the ordinary queue and the e-commerce queue require multiple visits to the same dealer box location. By integrating the two queues, e-commerce orders are collated with the ordinary queue generated order lines with destinations at the same end dealer. This is hypothetically similar to today's solution where employees pick product lines for multiple customers. Pickers continue to pick product lines where a separate freight notice is printed for each order line. The integrated solution decreases the handling time per order line and consequently increases capacity in the e-commerce queue, preparing ML for increased volumes in the future. With the e-commerce queue integrated, order line pickers can pick e-commerce orders simultaneously while picking ordinary order line queue assignments. Freight notices are automatically printed, exactly like the ordinary queue is organized today. An "e-commerce notice" is placed on the e-commerce parcel directly when picking, together with the ordinary freight notice. Also, order pickers sort different products according to destination (dealer boxes) while picking, and e-commerce orders are automatically assigned to the correct dealer box based on the customer's choice of distribution. However, as a portion of the e-commerce volume is sent by postal services and thus subject to separate packaging requirements, it is necessary to set up an internal postal service facilitator: a packaging station.

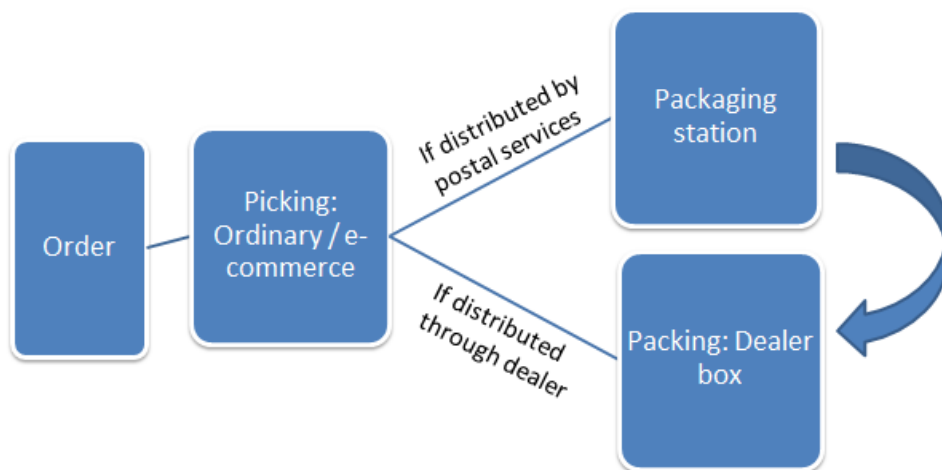
9.1.1.1 Packing station

The proposed solution is to establish a new packing location labeled e-commerce packing station. The optimized packaging workstation consists of assigned employees. When there is idle time, the employees should work on other assignments such as emergency orders, storing or picking. Packaging should consist of standardized cardboard boxes, which are able to fit the majority of products sold. As The Komplet Group demonstrated in their link between picking and packing, lean thinking should be applied when setting up the packing station.

9.1.1.2 Packing station sorted by transportation

Order pickers deliver postal distributed e-commerce orders to the packing workstation to finalize their picking tour. E-commerce products distributed by post needs to be separated from those distributed via dealers. This could be done by Astro, labeling the products differently during the picking tour. The packing station will be responsible for packing of postal distributed orders and further placement in the postal cage. The physical packing station will utilize today's e-commerce table setup, and take part of the emergency area. For all orders delivered by postal services, the cross docking (order consolidation) can happen as a part of the logistical solution delivered by Posten/Bring. It is assumed that e-commerce orders distributed through dealers are sufficiently packed already, and thereby ready to ship after being placed in the dealer box location without additionally packaging.

Figure 12: Process flow with the integrated configuration

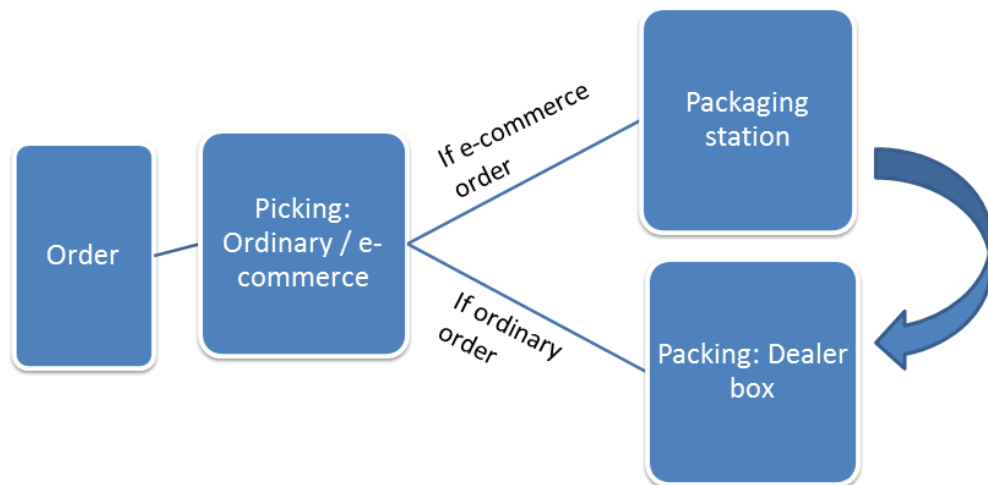


9.1.1.3 Packing station sorted by e-commerce

As an alternative solution, order pickers can deliver all e-commerce orders to the packing station. Then all e-commerce orders can flow through the packaging station to be packed and sorted according to right transportation location. This is especially applicable in cases where additional packaging contributes to added value for the customers. The packaging station will be responsible for packing all e-commerce orders and allocation and delivery of packed orders to the right location, respectively dealer box or postal box/cage.

The packaging process consumes an average of 1.91 minutes per order, and it is therefore worth considering whether to pack all e-commerce orders before re-distributing them to correct locations. In cases where additional packing can be considered non-value adding for customers, it can be expedient to not repackage products that are already fitted with packaging from suppliers. This could save initial time, money and may be more preferable from the customer's point of view as they no longer need to remove a second layer of packaging to enjoy their product.

Figure 13: Process flow with integrated configuration and all e-commerce orders going through packaging station



9.2 Alternative suggestion

As part of this master thesis, the warehouse management system Autostore is studied. This system revealed itself suitable for handling of e-commerce sales. As a result of this finding, it is suggested that ML introduce dialogue with provider of the Autostore system with the aim of applying Autostore at ML's warehouse. Therefore, our alternative suggestion to the integration is as follows: Partly utilize the Autostore warehouse management and operation system. This recommendation provides the cheapest daily handling costs, but the greatest investment.

9.2.1 Implement Autostore

The suggestion of using the Autostore system affects e-commerce operations, but also ordinary operations. As investment in such system is considerable with regards to money, but also with regards to system changes, physical changes in way of working, build up time and employee training, the system should be utilized at its maximum. The actual suggestion is a dramatic change in the warehouse layout, where all warehouse locations where minimum 3 products (dependent on product type) fit in the measurements of the Autostore box are replaced. This implies compressing the warehouse, and reducing the number of shelves and racks. Large products unable to fit in Autostore boxes are kept where they are today. The actual placement of the Autostore build is essential in order to optimize time consume in the day to day order handling. In addition to the actual Autostore boxes, ports and robots, manual stations to handle the order lines need to be set up. This process can be fully automatic by using for example conveyor belts. Alternatively, manual warehouse cars can internally distribute the products after Autostore has picked the order lines. We suggest building the Autostore cube close to the receiving and shipping area to minimize daily handling time.

Finally, it is worth mentioning that our model only considers variable handling costs. A system such as Autostore is a considerable investment. Due to the customizability such system requires, we have not been able to calculate this investment, nor have we found it relevant to our master thesis, since we are exploring options for efficient day to day handling. For exact figures on costs, the supplier of Autostore needs to be contacted and provided with data for each particular case. We urge further research to explore the area of generalizability in Autostore application.

9.3 Other suggestions

Our main suggestion is integration, alternatively Autostore. These two suggestions may function as revolutionary suggestions. We also urge to explore less revolutionary suggestions contributing to increased performance, and hereby propose incremental changes to the warehouse configuration related to e-commerce, and to the overall business.

- Discontinue e-commerce distribution via dealers.

This alternative involves outsourcing of e-commerce consolidation and transportation, and thus closer cooperation with third party logistics provider, for example the current partner Postnord Logistics. This means that all e-commerce orders are distributed by postal services, preferably home deliveries at the end customer's home address. As a result of this, all e-commerce orders will be picked and delivered to the suggested packing station at ML for packing and placement for pickup by the transporting company. This implies that ML does not need to do the consolidation and sorting of orders. All orders are delivered to the transporting company, which performs the geographically sorting and consolidation.

However, this option comes with some negative side effects. By not offering pick up at the dealer, which 79% of the e-commerce customer's uses, the dealers lose the possibility of achieving additional sales and increased customer contact. As it is today, e-commerce is perceived as an extra channel to move the customers to the dealer stores, and also reach a larger portion of the theoretical market. Also, not all products are possibly to distribute by postal services as some suppliers only deliver to dealers, and not home addresses. This option is a tradeoff between the value of additional sales and the value of reduces complexity in the order handling operation.

- Discontinue e-commerce distribution by postal services.

This alternative is the opposite of the abovementioned proposal, and implies that all e-commerce orders are distributed via dealers. This option is feasible because ML already has a well-functioning dealer distribution, which will be utilized at its maximum. This option leads to less complexity, as e-commerce orders does not need to be separated based on final destination, as all orders are placed in dealer boxes. This option assumes that our main suggestion "the integration" is implemented. Then, all products, independent of origin of the order, are placed in dealer boxes for further distribution. However, e-commerce orders need to be attached with "e-commerce" notice. This is to simplify the handling of goods received at the dealers. The packing station may be unnecessary with this configuration, as all products are placed directly in dealer boxes.

However, as part of this option, it requires additional changes to the current setup between ML and the dealers. IT-resources need to be allocated in order to integrate the dealers IT-system with ML's IT-systems. This is because the dealers need to have an integrated system with ML to handle and register reception of e-commerce orders to secure and structure customer pickups. Today, the procedure to call customers to inform about their ready e-commerce order is inconsistent between individual dealers. We therefore recommend setting up an automatic distributed e-mail or communication towards customers telling them that their e-commerce order is ready to be picked up at the chosen dealer.

There are negative side effects with this alternative as well. One of the great benefits with online shopping is the possibility of reception at home. This service will be removed together with the option of home delivery. Again, this is a tradeoff between service and complexity.

- Allocate resources to arrange efficient storing.

This option involves a thoroughly review of the current storing policy, which Astro manages in cooperation with the location dimension control, warehouse layout and re-order point. This alternative does not affect e-commerce processes directly, but affect all warehouse operations by increasing physical capacity. As it is today, many warehouse locations store products in an ineffective way. By utilizing each single warehouse location more efficiently, higher overall shelf utilization is possibly to achieve. As a result, shelves can be removed, and release capacity for other operations, for example packing and shipping.

Picture 28: Example of shelf utilization - employ on two top locations, full at bottom location



Picture 29: Example of shelves utilization - many empty locations



- Investment in IT-Resources.

It is identified that a bottleneck is the IT-department. IT-related issues and possible improvements are held back by lack of capacity in the IT-technical department. As a result, there may be difficulties in achieving prioritization in cases where other issues are perceived as more pressing. As an alternative, there are a lot of IT-resources available for purchasing in the free market which may be utilized in busy periods. The most important thing is to work on improvements while they still are current. Therefore, an overall suggestion is to increase the IT-resources capacity. This finding is generalizable for a large proportion of business. Today, IT resources at ML control a large portion of business performance. Efficiency and availability in IT-solutions and IT departments are crucial for service when required in order to make success.

- Increased and improved bank of data

In order to take the right decisions, the right basis for decision making is essential. We therefore suggest increased focus on data collection at ML. As mentioned, products dimensions would contribute to a better basis for our calculations. That could be solved by investing in a 3D scanner, and take measures of all products. This requires both initial investment and variable costs in the form of time consumed by measuring products. Our recommendation is still that ML - and all organizations - spends time and resources on collecting and analyzing data. However, this needs to be kept at a reasonable level, as too much data is useless. It is an individual tradeoff between the need for data and costs.

9.4 Conclusion: Answer to the research question

As our research question is “how to organize warehouse operations to secure a profitable e-commerce sales channel”, the study of ML has revealed findings of high interest to this matter. First off all, how to organize warehouse operations to handle e-commerce activities depend on the current operations of the business, and the current configurations of warehouse processes. Another affecting factor is the business's level of technology and the facing environment and industry. As ML is a heavy established actor outside the e-commerce market, there is revealed that it would be beneficial to utilize the current setup of warehouse operations and distribution. This implies adjusted e-commerce generated processes to fit current established routines and operations. In ML's case, this means integrating warehouse operations generated from different sales channels. On the other hand, as our study of The Komplet Group revealed, actors emerging with an e-commerce oriented view from the beginning faces other conditions. They build their business to handle e-commerce oriented sales primarily, and can optimize this channel without considering other sales channels simultaneously. The Komplet Group's preconditions for building a well functioning and profitable warehouse to handle e-commerce was somehow different from ML. They face different markets, and have a different orientation to business. Entering e-commerce markets and simultaneously secure profitability is about finding the perfect fit to current operations and ensure alignment of operations. In ML's case, profitability is secured by reaching certain sales volumes, in addition to aligning e-commerce activities with ordinary activities to minimize time and thus costs. It is identified that economies of scale are present in e-commerce. With these considerations in mind we conclude that a direct generalizable approach from our comparative analysis is inexpedient and therefore confirms the conclusions reached by Koster, Le-Duc and Roodbergen (2007) that there are no existing order-picking models that can be applied globally.

Customer expectations are different for “brick and mortar” stores and e-commerce. Delivery time is essential as part of the expectations. Internal warehouse operations affect the time perspective. In order to secure profitability, customer expectations need to be met. Also, price does matter, and the customers can easily compare prices online. A well-functioning online store is important, because online customers seek simple and convenient solutions. When these

factors are successfully in place and considered up and running, e-commerce actors can focus on improving their internal logistics and warehouse in order to secure e-commerce profitability. Warehouse activities are the main variable cost in the day to day activities, and also a potential competitive advantage. As our main proposal (integrating) suggests, our main finding in order to secure e-commerce profits by reorganize warehouse operations is based on utilizing already established processes and operations. There is no need for developing entirely new processes to handle e-commerce activities of large volumes. However, companies need to grasp the nature of e-commerce as a business concept, and thereby reorganize parts of their warehouse to handle e-commerce generated warehouse operations in an effective and smart way in order to secure profitability. As shown in the simulation of ML's warehouse, by integrating e-commerce order queues with ordinary order queues, time savings are achievable and thereby cost savings. However, automation has proved effective at The Komplet Group's warehouse, and is therefore worth investigating further for e-commerce actors. We urge businesses to search for the optimal e-commerce fit, that creates the least daily costly complexity and simultaneously generate increased customer value.

By analyzing available sales data for e-commerce from 2016, it is unlikely that ML will be able to reach their concurrent goal of 2016 (400% growth). Several factors are affecting this result; among these is the "diesel case" which has drawn strategic resources away from the e-commerce operations. Still, as the sales channel is considered a strategic focus area there should be a consistent plan to follow even in cases of "hiccups". Our research indicates that there is a large gap in the perceived strategic value of the e-commerce channel and the actual resource allocation. We have showed how internal logistics operations can help improve the profitability of the channel, but this alone is not enough to create a sustainable solution. Even in our simulation we assume that the internal issues regarding IT is solved, something that is unlikely to happen overnight. Additionally, the costs directly caused by the warehouse configurations are dwarfed compared to the current fixed costs. The fixed costs are however considered a necessity for the e-commerce solution to operate at all. In order to successfully operate a profitable e-commerce sales channel at ML, the sales volume must increase.

10.0 Limitations and further research

A clear limitation, which occurs with the usage of a single case study, is the inability to compare cases, and thus other type of businesses and warehouse settings. It is therefore difficult to suggest a best practice for the overall nature of e-commerce actors. However, this master thesis provides a thorough study of characteristics for a particular warehouse setting shifting towards e-commerce. The method and the main suggestions provided by the master thesis can function as a basis in other comparative case studies.

In order to secure profitability in the e-commerce sales channel, the e-stores itself needs to function properly. In this study, we assume they are functioning and that the current issues are solvable. Thus, we do not set restrictions for growth based on the current e-stores. Further research can however study e-stores and investigate elements for success, and how to build e-stores in order to meet customer expectations and requirements. These are factors affecting e-commerce success, and also e-commerce profitability through converting rate and sales. E-store factors may be design of the stores layout, pictures and product descriptions. Also, further research can provide studies on how to build a complete e-store business, from warehouse operations through transportation and e-store design and elements.

This research only studies one automatic warehouse system, the Autostore system. There is however worth mentioning that there exist substitutes to this system. The reason why we only considered this system is because we wanted to limit and dedicate our research to e-commerce and warehouse operations, not towards finding the perfect automatic warehouse system for e-commerce. However, as Autostore utilize unique technology and have developed a revolutionary system, we highly believe our effort to investigate Autostore is a reasonable choice with our limits of research. Further research can study how other automatic warehouse systems may affect e-commerce activities. In addition, this study does not account for the complete Autostore investment. Further research could include an investigation of how to generalize Autostore investments, and how the investment in Autostore affects businesses.

Unobtainable product dimensionality proved to be an obstacle in the computation of the Autostore warehouse conversion. However, the lack of data in this matter is hardly affecting ML's current operations. Future studies could expand on this notion and investigate comparable effects on performance between companies that log and lack these measures.

As our excel model obtains data from different data files, data systems, time intervals and data extracted from different people, we assume they are correct. However, if inconsistencies are revealed, we have investigated further. As the model is assembled by utilizing the different types of data and own interpretation and calculations, we are aware that the model is not absolute. The function of the model is more of a guiding. Further researchers can put effort in developing a similar model that addresses longer time intervals both regarding sales volume and time usage.

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12.0 Attachments

12.1 Attachment 1: Routing heuristics

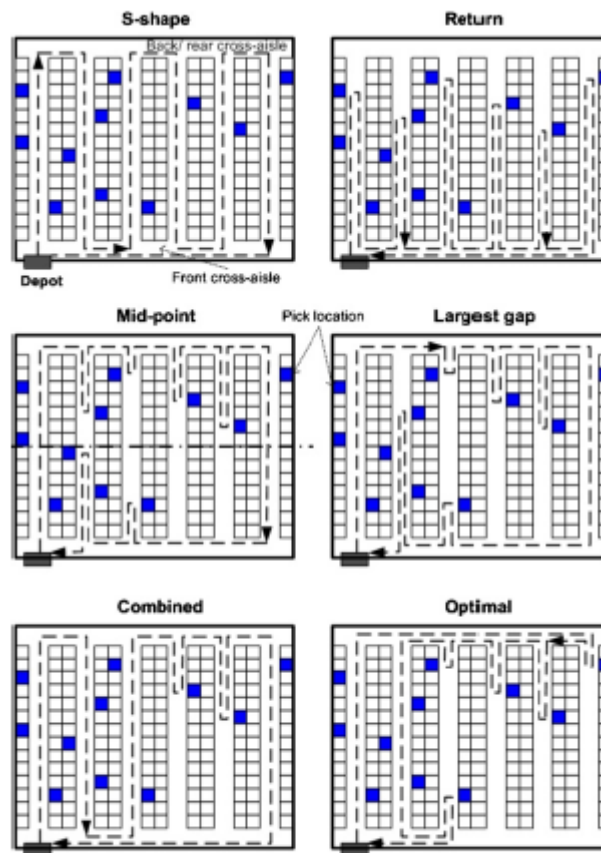


Fig. 8. Example of a number of routing methods for a single-block warehouse (Roodbergen, 2001).

Source: Roodbergen (2001)

12.2 Attachment 2: Interview guide**Interview guide**Before interview:

- Internally discuss overarching topic and reason for the interview.
- Write down questions and topics for discussion for usage in the interview.
- Send the questions and topic to the person of interest before the interview happens. This is done to allow the interviewed object to prepare.
- Prepare on relevant topic.

Note: As part of our preparation for our meeting with The Komplett Group, we reviewed several sources and news articles describing The Komplett Group's warehouse operations and the Autostore system (Stokke 2013; Loftås 2009; Henning Ivarson 2015; Qvale 2013; Ludt 2015; Sinus 2009; Brenna 2007; Hagevik 2015).

During interview:

- Ask questions in line with the prepared questions. Ask follow up questions when necessary, and discuss the topics.
- Write down key answers and processes.

After interview:

- Write detailed summary of the findings in the interview.
- Discuss the findings, and find consensus.
- Send follow up mail regarding clarifications to interviewed object if necessary.

12.3 Attachment 3: Interview protocol**Summaries of key interviews****Key interview 1****01.03.2016: E-commerce processes****Agenda: Understand e-commerce generated operations**

The purpose of this semi-structured interview was to acquire practical insight of the daily operations connected to the flow of goods in the E-commerce channel.

We got the opportunity to follow an employee through the process of picking and packing.

Orders are automatically logged in Astro. Production managers release these orders; this is the only way that orders are made available for pickers and packers. The released orders are displayed, either on a computer or on a PDA, as queues. Queues are organized according to rack and row clusters. While orders are given a picking priority, it is possible to start picking another order with a lower priority. When a queued order is activated, the order is locked for that specific PDA and a product notice is printed at the printer connected to the PDA. From here, Astro will propose a picking route. We know that this route is not always followed and that there are several reasons for this. One reason is that Astro does not take into account the traffic generated by multiple trucks picking from adjacent locations.

After physically moving to the SKUs location, Astro asks to verify the position by confirming three-digit code that has randomly been assigned to the shelves location. When this is registered, Astro confirms either that you are at the correct location or tells you if you are at the wrong place. From this, the picker needs to confirm the number of items to be picked. This is done by manually counting and writing the correct number on the PDA screen. The units are then placed in a temporary and mobile storage area and transported to the packing zone.

Packing is done manually and recorded by utilizing a stationary computer with Astro Software. E-commerce batches needs to be converted manually because a freight notice is not generated automatically for these E-commerce products. The freight notice is placed on the product or cardboard box. Large products are

placed directly in dealer boxes unless they are classified as fragile. The procedure to follow in such an instance is to place it at the backside of the designated dealer-box row. Some products are sent directly to customers with postal service. In this case the products are defined as packed when placed in a cage. Dealer boxes have their own designated area, but boxes destined for Oslo are handles at the start of the day. Thus there is a shift in Oslo dealer-boxes which are replaced by those that are to be delivered at other locations over Norway. In cases where the appropriate dealer box is not present at the time, the products are temporarily stored at a separate table in the packaging area.

E-commerce orders are continuously picked and packed by the same employee separated from the ordinary flow. The current setting is that there are two tables where one or a few employees handle all e-commerce activities after customer orders are placed. The largest share of e-commerce orders are delivered to dealers and picked up by customers at the nearest dealer. Therefore, the e-commerce orders have to be sorted in the same dealer boxes as the ordinary flow. The result of this is that two or more different people are packing products in the same dealer box. E-commerce orders going directly home to people are placed in a cage, picked up by Bring.

Key interview 2

04.03.2016: Astro

Agenda: Acquire knowledge of Astros role in flow of products.

General information: Astro is a warehouse management system (WMS) and is a standardized product. Still, it is possible to adapt the system to ML's needs and there have been several changes. The Astro system is based on input that requires SKUs to be logged as complete parcels, this is very difficult (Impossible) for ML as the product come is a variety of shapes and sizes. Kassel is the VW warehouse in Germany.

There are two processes for inbound goods: A02 and A02.

A02: handles products where quantity is confirmed and in general there is more information available for the products that are received. There are four levels for products:

-
1. Transport:
 - a. Might be the train arriving
 2. Sending:
 - a. Might be a basket or a parcel with multiple products
 3. Parcels:
 - a. Same article number. Example might be 1-100000 (more) of the same product. As long as the goods have the same article number.
 4. Article batches
 - a. Pretty much the same as parcels.
 - A03: Is typically accessories. Here product quantities are not pre-confirmed, but it is not expedient to confirm the quantity manually so the product order list is logged as storage input directly.
 - M02: Is Astros office client name
- Master client, we cannot pick, move or pack parts in this program. You need O02 for this
- O02: Is Astros client for the truck drivers
- Work on parcel level
- H02: Is Astros client on the PDA
 - L02: Is Astros client at the paternoster
 - A05: Special orders

These products are not available in stock and are thus ordered from another elsewhere. When the goods arrive at ML, the product is already reserved for one particular dealer. By scanning the label, information about packaging location will be displayed. For parts that are delivered as a part of a special orders, but that are not going directly to dealer, the products are called LKW storage.

The flow of Astro: The manager for inbound goods registers the arrival of goods in M02. The command for this is to right click and press “arrive” and then choose the correct destination. Another person with a PDA and the O02 client chooses the unload function and scans the parcel. Astro now knows what to do and responds by auto-accessing a new tab in the O2 client. Astro asks to confirm quantity and this is counted manually to the extent it seems reasonable (example: it is not reasonable to count a shipment that has between 200-2000 units exact. After this, a note is printed and is applied at the article or article box. Astro then proposes a

box to sort the products in. After the product is placed (manually) in the box the ok button on the PDA must be pressed. Then Astro will interpret the information in a way that changes the status of the product to “unloaded” and the parcels will be assigned a “storage parcel number”.

The flow specific for A03: Using the payment information of the order, you right click in Astro (M2) and shift status to: Arrived and set location for arrival (example ITIL which is for accessories). A PC is normally used as both M2 and O2 must be used and this is a bit more difficult on the PDA. In O2 we need to receive the products at article batch level because we do not have any “parcel number” information available. To continue, we either utilize the article number or press “ok” to review the information that is available for the entire sending. From this point we have to create the “parcel number”. Usually it is enough to just click ok rather than utilize the article number. Thus a “parcel number” is created. Astro asks to confirm quantity and this is counted manually to the extent it seems reasonable (example: it is not reasonable to count a shipment that has between 200-2000 units exact. After this, a note is printed and is applied at the article or article box. Astro then proposes a box to sort the products in. After the product is placed (Manually) in the box the ok button on the PDA must be pressed. Then Astro will interpret the information in a way that changes the status of the product to “unloaded” and the parcels will be assigned a “storage parcel number”. From here the products are ready to be stored at their assigned location. We can say that there is one more process step for A03 which is to create the “parcel number”.

Storing: There are two ways in which products are stored, either at picking location or buffer location. The picking location is easily accessible while the buffer location typically is positioned at the top shelves (stored in height). There are approximately 2000 different products that have designated buffer locations. When goods are placed at their shelf location, the person responsible for storing scans the shelf and Astro receives a “Balance change” under the tab “surveillance and transactions”. There may be some bugs with this process connected to e-commerce.

Order release: When this process is reached, Astro calculates the order batch size so that the pickers are able to take one trip and then place the products in different

dealer boxes. Pickers are assigned to one queue, which is organized according to shelf location.

Key interview 3

08.03.2016: E-commerce and e-stores

Agenda: Questions about E-commerce

Walkthrough of the order: WSC gets information about warehouse status. Data is gathered from M-Nett. When payments are accepted through Nets an automatically generated order is sent from the E-commerce channel to ML. For third party products, the procedure is that an automatic email to the leader of the E-commerce sales channel and he orders these products from supplier and sets delivery for the store closest to the customer's location. When the product is registered at ML as packed (this process is already described in a previous meeting), an automatically generated SMS or email is sent to the customers that tells them that the product is in transit. When the goods arrive at the dealer's location, the dealers have to manually tell the customers that their products have arrived (this does not always happen). The telephone number of customers are sent by email, thus the dealers have to check the mail and corresponding parcel number to figure out which customer to call.

Service after marked: organized as following, one chief of sales, three purchasers and three product specialists. Products are established as a digital draft. John is able to verify which products to add at the e-commerce platform all products are added to a digital catalogue. The E-commerce platform does not sell any products that are difficult to install there are several reasons for this but one that we didn't think of is that this lessens the need of customer support.

Prices:

MPS control all data that we receive from the factory. The process is automatic. Prices are calculated cost + markup. M-lager (Internal storage program) is connected to the unique dealer ID, this is because M operates with different transportation fares. For E-commerce the ID is set to Oslo.

There have been some issues between E-commerce and dealers regarding prices of products this has led to the point where e-commerce has withdrawn some products from the store until these issues are worked out. Still, the dealers receive a kick back from E-commerce or an incentive. This can be interpreted as almost free cash for the supplier (they do however handle the final delivery).

The conversion rate of customers is about 1.6%.

Why are so many of the products sold out?

This is because the products at the E-com sales channel undergo number transfers which basically happen with incremental changes in products or packaging. Example: one product is named xxxx3 but after changing to a new cardboard box the name changes to xxxx4 the system cannot interpret these changes automatically and therefore returns the value “out of stock”. Another issue is that some products are only available for from suppliers one time, this refers particularly to Clothes under the lifestyle tag.

Key interview 4

15.03.2016: Picking operation

Agenda: Understand the picking operation

The locations of products are not fixed. If an employee is unable to fully pick an order, a yellow colored note is printed and the PDA/Astro tells where to pick the remaining products. This procedure overrides the next location for product picking and employees risks moving to a completely separate location (That is often within the same defined picking area or at the overstock location). A red note indicates that the product is out of stock. Picking employees are dedicated to different picking zones. “The floor” is counted as a work station with separate queues K, P, O and M. In addition these queues also have pickers that use forklifts to reach higher shelf positions. Both paternoster and volume have their own queues. There are different types of equipment used for the different areas. For example are “floor” one own area, where “car” is used as equipment. These types of order lines are picked from cages placed at the floor. “Height” area is picked by lifting truck. These areas are again divided in different fields.

Orders are prioritized by the production manager. Oslo is always managed first, because they are shipped first. Warehouse employees are assigned to different workstations which handles several racks. Astro calculates an optimal or close to optimal route in the different zones and the employees follow this route picking suggestion. When arriving at the product location, the shelf is scanned or a reference is typed in the display at the PDA. After this, Astro asks to confirm the number of products. Confirmation is executed by pressing ok and order line labels are printed out on mobile printers that are connected to the picking car. Labels are tacked on products based order lines, not each and every product, independent of the number of items in the order line. If the products are supposed to be visible in the dealer's stores, the label are tacked on plastic which is wrapped around the products. This applies for example for wipers. Also, some products have expiry date, which need to be verified when picking. The order lines are then sorted on the trolley on the car based on packing destination (dealer box). If employees for some reason (lunch) are unable to finish the picking tour, then the order can be released and completed by others. This also implies that a picking tour is locked after choosing.

Introduction to Astro: The new system Astro has been somewhat problematic to deal with in the implementation year. One employee shared some thoughts regarding the process, stating that the knowledge acquired in the “old system” was comparable to production managers. The Astro system has reset this knowledge, bringing a majority of the employees to the same level. Some may experience this as a relief and an opportunity while others lose their position as more knowledgeable.

Emergency orders are the umbrella workstation that incorporates E-commerce. The queues here are organized in a way that allows employees to choose the tour picking order themselves.

The handling employees are measures based on picking errors, wrong packing, mistakes and other errors. One “error” in Astro is that errors made by packers who packs order lines other employees has picked, the error are allocated to the picking employees scoreboard.

Key interview 5

02.05.2016: Warehouse operations at The Komplett Group

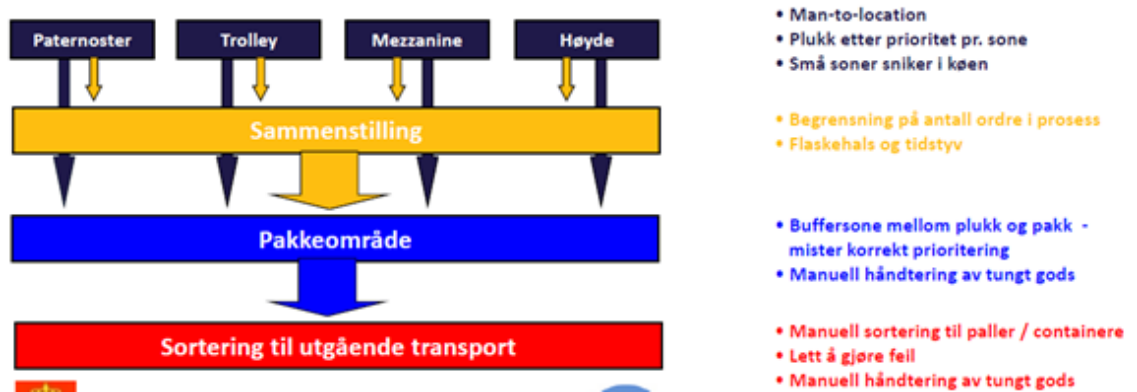
Agenda: Understand The Komplett Group's warehouse operations

After we were given a tour in the warehouse at The Komplett Group, we discussed warehouse topics with a warehouse director.

The transition from manual to automated storage was not without hiccups. One of the challenges was also created from changing the warehouse management system alongside the automatization. The Komplett Group depended continuing their operations alongside the implementation and there were several miss-deliveries.

Figure 1 illustrates the prior working process. From Man-to-location zone picking, through compilations and the packing workstation and finally to sorting and outbound transportation.

Figure 1 “Old process flow chart”



Source: (Vindegg 2016)

Figure 2 illustrates the current process with Autostore.



Source: Vindegg (2016)

The bin size of Autostore restricts the possibilities for which products that can be stored. Products too large need to be consolidated as “uglies”.

The year 2014 is seen as representative for addressing “down time”. In total, the operations stopped for 17.2 hours from a total of 44088. Still, this does not come without costs attached. There has been a strategic investment in employee competence regarding service and technicians. To account for this, the management has included the costs in their productivity calculation.

The shift to Autostore is considered an act of corporate cynicism or a consideration regarding the bottom line of the firm. Historical contact with the Hatteland group was a factor in conjunction with the more “geeky” profile that The Komplet Group has. In Norway, the salaries are roughly 30% higher than in Sweden, the consideration was therefore that investments were needed in order to continue with their operations in Norway. In that sense, there are also some non-economic considerations that have been taken. The Komplet Group also got a good deal with element logic because the warehouse is considered a pioneer and they use The Komplet Group as a success story (show them off to potential customers).

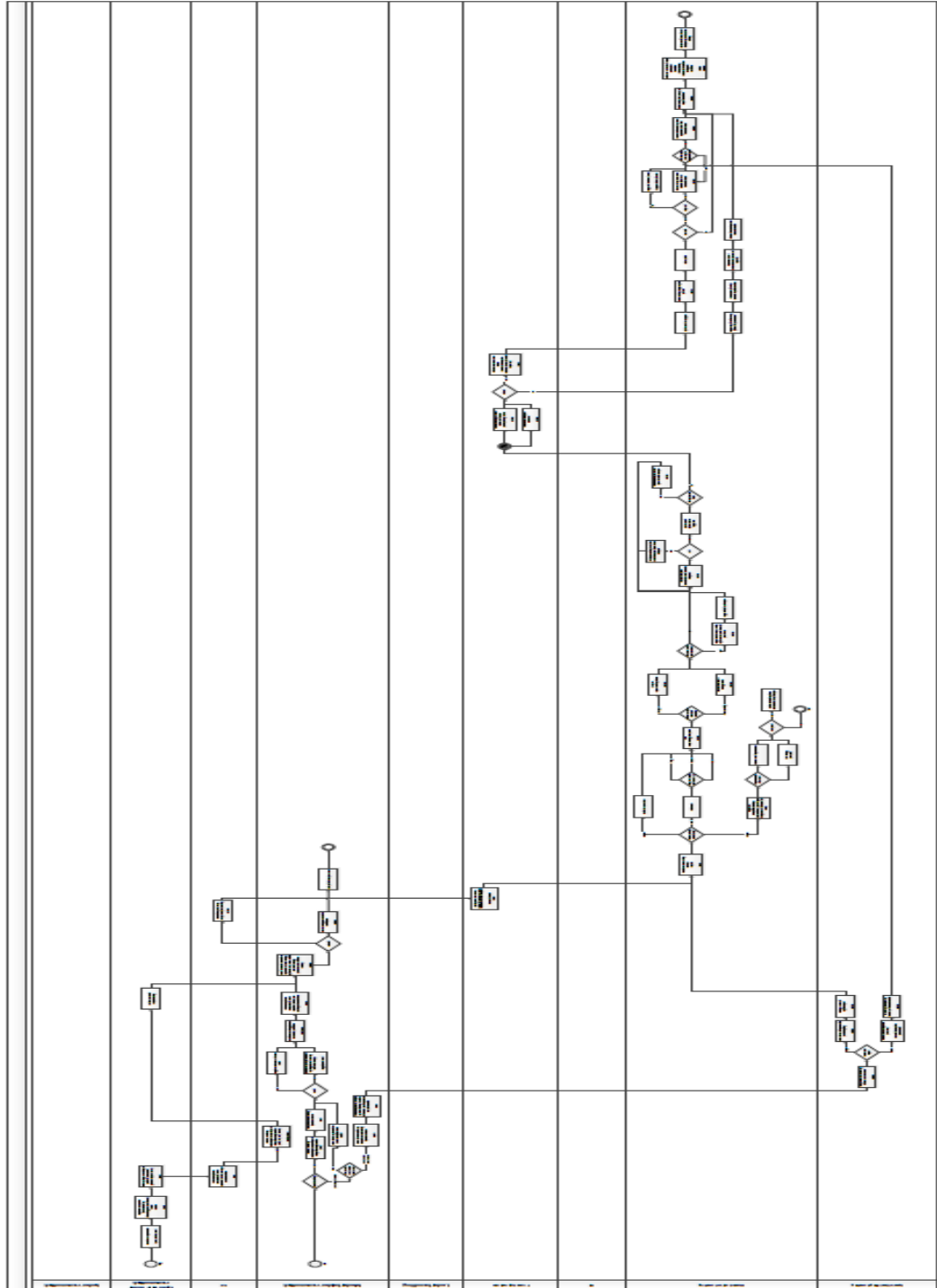
Inbound goods are received manually up until the point where the goods are placed at Autostore. Everything that does not fit with the Autostore containers is placed at a manual storage facility. Goods are buffered at the top of racks whereas all products are placed easily accessible on the ground for picking. For both storing and order-picking, we utilize the conveyer as well as the carousel port. The latter did not exist until recently and is more effective. This is mainly because the carousel does not bind the robot to the packing process. Uglies are still received, stored, picked and packed with manual processes.

Autostore:

The criterion for utilizing the Autostore System on product level is that three products need to fit in the bins. Now however, this is challenged and it is speculated that Autostore is more effective for all products that can fit in the bins. This includes only one of each product.

Currently there are approximately 72000 bins, which are handled by 75 robots. There are no systemic challenges with the number of robots, but the system does experience occasional downtime. The downtime is mainly caused by human errors. In this regard, one example that were brought to our attention was that the automatic fire extinguishing system was installed to low, causing one of the robots to trigger it. The result of this was to turn of the entire system.

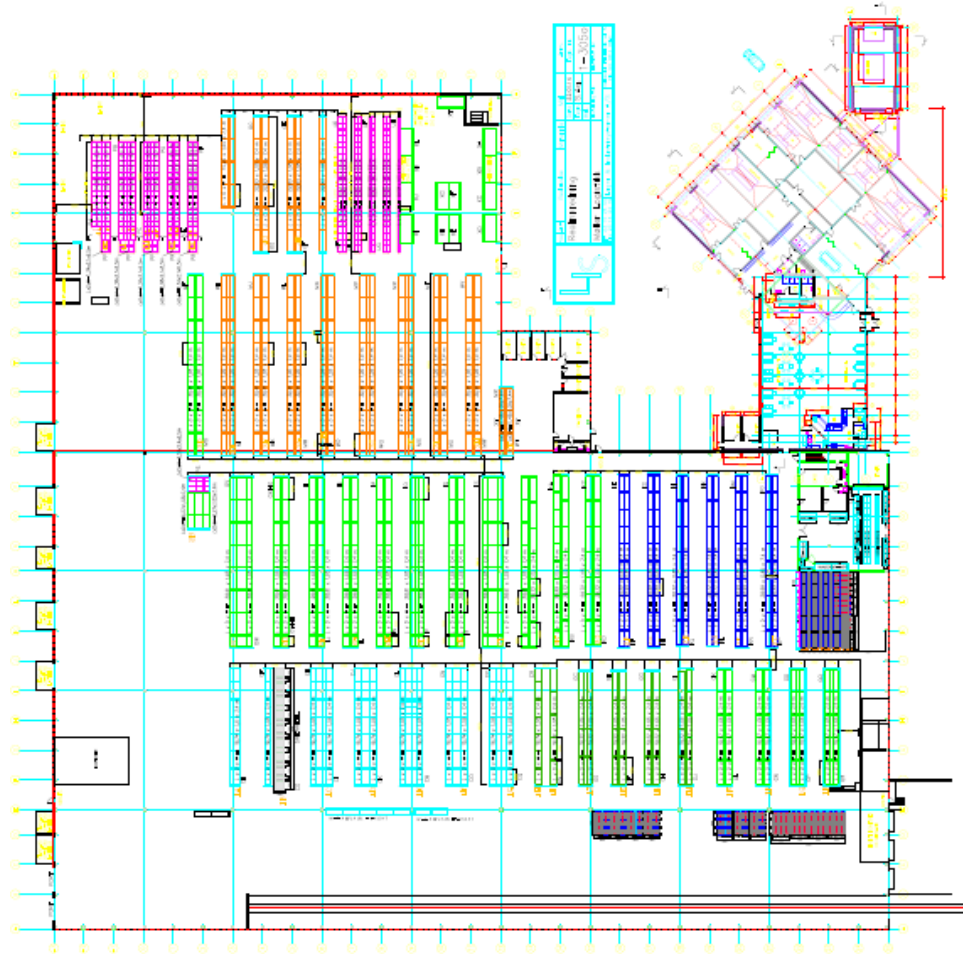
12.4 Attachment 4: Process flow chart



Source: Sopra Steria (2015)

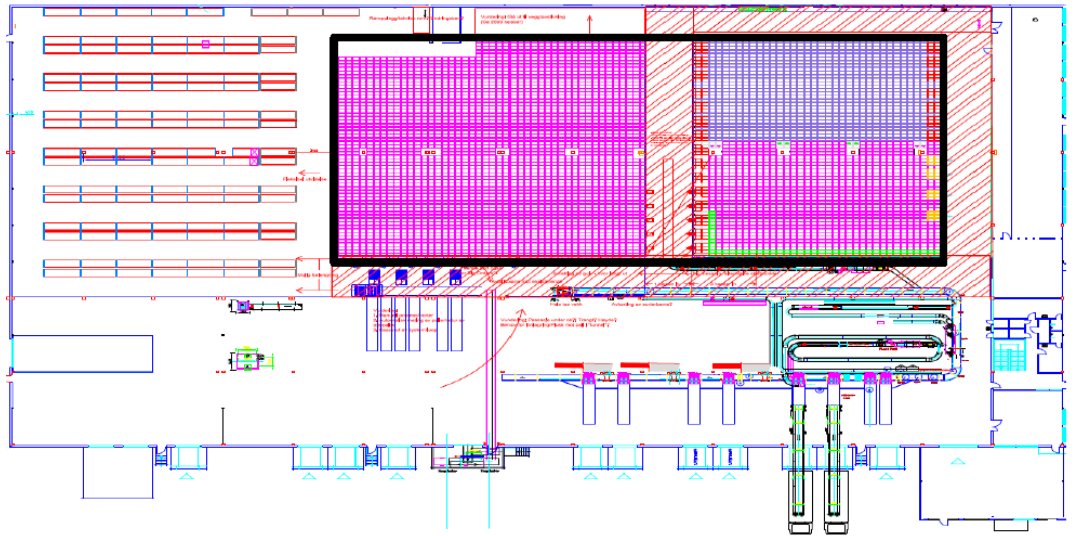
The process flow-chart utilizes three different geometrical shapes with different interpretation. Circles denotes start and end points of operations, rectangles represent processes with a single process following, while diamond shaped boxes indicate processes with more than one response. At the lower end of each figure, the internal tools necessary for process completion are listed.

12.5 Attachment 5: Warehouse layout at ML

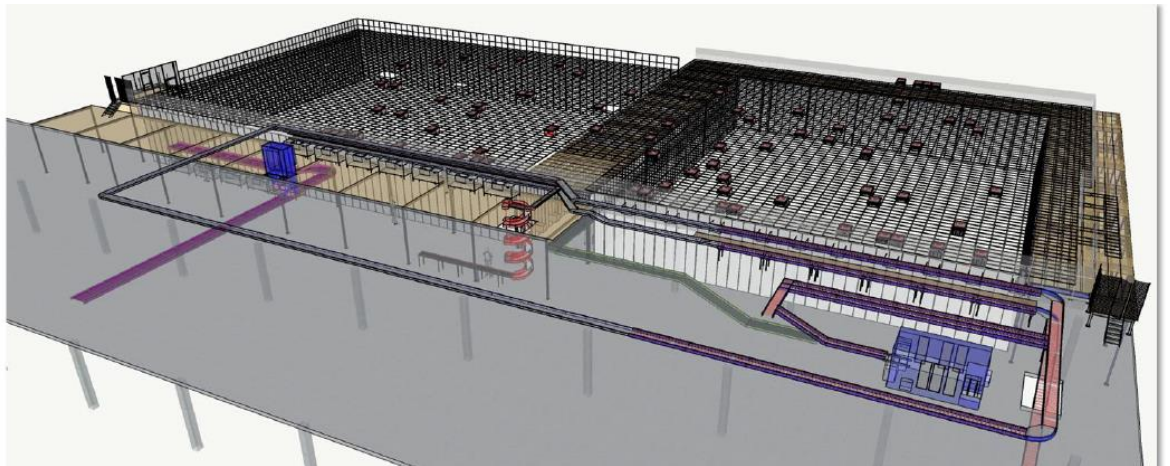


Source: Møller Logistikk (2016)

12.6 Attachment 6: Warehouse layout at The Komplet Group



Source: Vindegg (2016)



Source: Vindegg (2016)

12.7 Attachment 7: The excel model - simulation

The blank cells are made whited due to sensitivity.

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5	Nettbutikker administrering		Fast	Lønn											
6	Markedsføring		Fast	Programvare /admin											
7	Faste kostnader	-1 702 500		Markedsføring											
8	Lagerhåndtering lønn		Variabel	Antall arbeidsdager i året		230									
9	Varekostnad		Variabel	Tidbruk per e-orde linje (dagens) (min)		4,17									
10	Kostnad Posten		Variabel	Tidbruk per e-orde linje (integret) (min)		1,36									
11	Totale kostnader	-2 460 465		Tidbruk per e-orde linje (automatisk) (min)		0,50									
12		-4 162 965		Tidslønn											
13				Lønnskostnad per time											
14				Lønnskostnad per min											
15	Salgsinntekt	2 900 000	Simulering	Antall årlige ordre (snitt)		2 065									
16				Antall ordre hver mnd		172									
17	Resultat	-1 262 965		Antall ordrelinjer hver dag		16,6									
18				Andel post (februar 16)		21 %									
19				Andel hente hos forhandler (februar 16)		79 %									
20				Snittpris per forsendelse (post)		98									
21	Break even	11 232 884		Tilgjengelig arbeidstid per dag per ansatt (min)		450									
22															
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24	Mål (lekning)		Scenario												
25			Scenario 0												
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Preliminary Thesis Report
BI Norwegian Business School

*“Preparing for the future: How to
organize warehouse operations to
secure a profitable e-commerce
sales channel”*

A case study of Møller Logistics

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Summary

This preliminary thesis will introduce the topic and background of our master thesis, relevant literature, research methodology and project plan.

The first section presents the background and current setting of the topic and theme of this thesis, which is how a traditional logistics actor can redesign warehouse operations with the purpose of preparing for increased E-Commerce activities. A discussion regarding the choice of the case and company Møller Logistics is provided before arriving on the research question and accompanying sub-questions.

The second section is dedicated towards reviewing relevant academic literature and covers: Warehousing with process flows, comparative analysis and warehouse model development. The purpose of the literature review is to provide the foundation for theoretical relevance of the thesis while ensuring consistent academic terminology and language.

The third section account for the research methodology in the thesis. A mixed method case study is selected as the appropriate strategy and design.

Finally, we have suggested a preliminary project plan. The plan consists mainly of activities related to data gathering, processing and analyzing.

1.0 Introduction

Electronic-commerce (EC) is described by Moraaur (2008) as a process where two parties are executing buying and selling of goods and services over an electronic network, primarily the internet. In 2013, the Norwegian EC marked consisted of a total volume of around 27,5 billion NOK which grew to approximately 33 billion in 2014, representing a growth of 20 % (Wangsness 2015). Consumers spent on average around 8300 NOK on online stores in 2013, which increased to approximately 10 000 NOK in 2014. The marked is experiencing growth in both number of people performing EC, and the share each consumer are spending. However, EC is still only contributing to a fraction of each household's total consumption; from 1.8% in 2013 to 2.7 % in 2014. EC accounted for 5.2% of the total consumption of goods in 2013, and 8% in 2014. Future growth is expected to come from increased spending per consumer, rather than growth in the number of customers (Wangsness 2015). This market development has inspired corporations to strengthen the company's strategic position by establishing a foothold in the EC segment.

In the light of this observed trend, the Møller Group's (MG) subsidiary Møller Logistics (ML) are interested in how to prepare their supply chain (SC) and warehouse operations to better cope with the emergent shift in customer buying behavior. In order to sustain the ability to compete it is perceived as essential that traditional operations are maintained, while simultaneously focusing on online sales. This raises the overarching question: How to configure a future distribution warehouse to handle parallel sales strategies? By parallel sales strategies, we are referring to the traditional based SC, and the EC driven SC. Re-configurations to handle parallel sales strategies in a SC increases complexity. This latter topic relates to the SC systems and activities of distribution and transportation, the handling of incoming and outgoing goods, the picking and packing, but also potential returning of goods. The supply base may increase, while new system integrations are required. Arising challenges are how to organize the warehouse, setup of warehouse operations, distribution system, incentives in the SC and transportation.

Because of the information technology (IT) development, several actors have emerged to conduct business exclusively through an EC platform. Business

examples of such actors are Komplet.no and BS Bildeler. As the development of IT proceeded, related novel ways of business process redesign also emerged, creating turmoil in various industries (Phan 2003). Exclusively EC-actors have critical competitive advantages such as the interface of the online sales platform, purchasing and supplier relationships, and logistics. The EC actors have developed “top in class” configurations to their SC network to handle online sales. The task lies in redesigning the links of the SC. This can however create ripple effects in other linkages of the SC. Avoiding sub-optimal solutions is the key, especially for actors “new” to EC.

The car industry has traditionally handled sales and customer relations by physical presence manifested as “brick and mortar stores”. This philosophy is still present in today's car dealers market. However, some companies providing the market with cars, accompanying equipment and spare part wants to revitalize elements of their concept, by rethinking market perception. MG pay attention to the technological changing environment and have launched web stores as an additional sales channel for car equipment, related merchandise and accessories. The goal is that EC will increase overall market visibility, sales and capitalization. According to Phan (2003) integration of IT and EC channels to redesign processes can strengthen EC actors competitive advantages. In the light of this, we find the MGs emphasis on EC suitable for a research study.

1.1 The current setting

The Master Thesis will be written in cooperation with ML, i.e. MG's logistics division. MG is the Norwegian car importer of Audi, Volkswagen and Skoda. ML is the main distribution warehouse of spare parts and equipment for the mentioned car brands. The organization form one of the largest Norwegian logistics actors, serving 124 different drop-off points over the country. The warehouse itself is a 16 000 m² building. The organizational unit is capable of handling over 2.8 million orders on a yearly basis. At any time throughout the year, the expected tied up capital lies somewhere between 100-120 million NOK. The revenue for 2014 was approximately 1 billion NOK.

Warehousing operations are mostly handled manually with employees assigned to different workstations. The IT system proposes where to store inbound

products and immediately pinpoints the stock keeping units (SKU) location for outbound handling and transportation. The IT system is capable of handling both the traditional and the EC strategies in parallel. Product pickers do not distinguish between the processes other than that the product is delivered to different packaging stations. The packaging operations are separated between the sales strategies with employees dedicated to task execution. The majority of EC products are shipped to dealers, who also serve as pick up points for private customers, while some are shipped off using Posten/Bring with the intent of reaching consumers doorstep. Sales in the two market strategies are disproportional where EC corresponds to less than 1% of total volume. It is therefore hypothesized that the operation should be executable without sorting to separation between packaging tasks. The current way of organizing could be more costly and is potentially more space intensive than required. This last argument may deserve heightened importance as sales volumes generated from EC increases.

ML has developed separate online stores for their imported car brands i.e. “Volkswagenbutikken”, “Audibutikken” and “Skodabutikken”. The stores sell products such as exterior and interior merchandise and equipment. Technical spare parts e.g. brake pads are sold exclusively through dealers. ML is however interested in expanding the product selection. A significant proportion of the product sales go through the dealers. The end customers visit the dealers to conduct their purchase. ML expects that there will be an increase in the share sent directly to customers, sold through their online sales platforms.

ML’s objective for 2016 is to increase online sales by 400%. ML holds high interest in how to adjust their warehouse configuration in order to be suited to handle this target. It is expected that this goal will imply new hires, more stock keeping space, overall increased complexity and ultimately higher costs. One of the ideas presented to cope with these issues is to apply a framework of best practice. In order to provide the readers with an understanding of the current warehouse setting, we have developed a model (see attachment 1). In this thesis, warehouse configurations are defined as all warehouse operations and corresponding activities with the addition of workstation composition with employee organization.

1.2 Research question and problem statement

This thesis will seek to answer how the e-commerce sales channel affects current warehouse operations, and how this strategy can be profitably organized in parallel with the existing sales channel. The output of the research will be a model that helps company decision makers with choosing the organization configuration at an optimal or close to optimal level. Conclusively, we have derived the following working title and preliminary research question:

“Preparing for the future: How to organize warehouse operations to secure a profitable e-commerce sales channel? A case study of Møller Logistics.”

In order to respond to this broad question, several sub-questions are identified. Analyzing and answering these questions will contribute to reaching the goal of achieving profitability in the E-commerce sales channel. For an in-depth discussion of our stepwise process, we refer to the section “3.3.1 Method”. It is worth mentioning that the product prices and transportation prices are considered fixed. As a result, we will work with the cost aspect of profitability.

- How is the e-commerce sales channel affecting current operations?
- How to achieve economies of scale between the traditional and e-commerce sales channels?
- How to minimize e-commerce warehouse operation costs?
- Which performance metrics to extract from “best in class” logistic actor?
- How to build a warehouse performance model for scenario planning and decision-making?
- How to simulate e-commerce sales-channel effects on profitability in a model?

1.3 Purpose of the thesis

The study aims to understand how a traditional actor redesigns elements in their warehouse in order to be prepared for increasing EC activities. Results of the thesis is expected to provide ML with tools contributing to the decision making process regarding warehouse operations. The overall goal is to provide recommendations for how to (re)organize warehouse operations given the strategy

of quadrupling EC sales and achieve profitability. The recommendations should be based on simulations and scenario planning enabled by a research model and supplemented by an external comparative analysis exercise. It is hypothesized that the comparative analysis may propose valuable configuration information and give practical suggestions for reorganization.

1.4 Limitations

The usage of models in research requires simplifications of reality (Hornby 2000), thus there may be elements present in reality which the models do not take into account. Such elements may be variation in employee productivity, errors in measurements, accidents and external delays. As a result, the model is not a perfect replication of reality, but will serve as our best estimate for suggesting re-configurations and measure performance without changing practice and observe effects. Another limiting element is the period of the research. Instead of conducting a full benchmark, we aim to conduct a comparative analysis of another actor. We are confident that this approach will give valuable inputs and add extra dimensionality for model purposes.

While the overall SC is considered, the primary scope of the thesis is within and about the proximity of the warehouse. Because of this, we limit our model to include warehouse elements, not distribution elements. The focus of the thesis will consequently be more in line with the sets of interrelated activities the focal company uses to gain competitive advantages (Porter 1985), rather than the connected processes involved in upstream and downstream activities towards value creation (Mentzer et al. 2001), but with SC considerations without a supply network approach (Persson, Håkansson and Gadde 2010). Consequently, the analysis is more compatible with a value chain analysis. This thesis's level of analysis focuses on the micro level perspective rather than the meso level perspective.

2.0 Literature review

The purpose of the literature review is to obtain an overview of the existing academic literature on the field of thesis relevance (Biggam 2011). In the following section, we review the importance of the warehousing role in supply

chain management with related operations. Then we review necessary considerations for conducting a comparative analysis and model empirical findings.

2.1 Terminology and background theory

The warehouse term can be used to describe a facility whose main function is buffering and storage of SKU or items. If distribution can be regarded as an additional major function, it is common to use distribution center, whereas transshipment, cross-dock, or platform center are often used if storage hardly plays a role (Koster, Le-Duc and Roodbergen 2007). Similarly, van den Berg and Zijm (1999) define a distribution warehouse as a facility that store products from multiple suppliers which ultimately are to be delivered to a number of customers. In this thesis, we will follow this latter definition. The main ML facility can, in accordance with the aforementioned terminology, be classified as a distribution center. A distribution warehouse is a facility in which products from different suppliers are collected for delivery to a number of customers (van den Berg and Zijm 1999). The warehouse generally consists of a number of parallel aisles with products being stored vertically alongside. Many companies continue to use manual order picking due to variability in SKUs shape and size (Petersen and Aase 2004). Other factors favoring manual labor are; variability of demand, seasonality of products and large investments required for automating an order picking system.

The principles of SC management underpins the importance of achieving high-volume production and distribution using minimal inventories throughout the logistic chain that are to be delivered within short response times (van den Berg and Zijm 1999). In literature, the traditional models for logistics have focused on contributing towards profitability by minimizing costs subject to operational constraints (Sbihi and Eglese 2010). Warehouses plays a vital role in modern SCs and are critical for the success or the failure of the business (Baker and Canessa 2009; Lu et al. 2015). Main functionalities range from inventory buffering to handle seasonality and variety in demand, but also to deal with consolidation of products from various suppliers for combined delivery to customers (Gu, Goetschalckx and McGinnis 2007).

The product manufacturer seldom manages to meet customer expectations and demands with regard to lead time, while simultaneously operating with a feasible cost structure (Harrison and Hoek 2007). This finding indicates that both the customers' needs and associated costs of operations are better met by being served from inventory keeping facilities. This argument is supported by Li and Kuo (2008) who state that an inventory of spare parts located in a central warehouse plays an important role in improving the service level and reducing the operation cost of automobile SCs and logistic systems.

Faber, de Koster and Smidts (2013) defines warehouse management as a group of control and planning decisions and procedures. Planning and control are in turn depicted as organizational procedures concerned with managing the ongoing activities and operations within the warehouse system (Rouwenhorst et al. 2000). The main objective is to ensure that the correct stock level is available for each item, the tied up capital in inventory is kept at a minimum, the warehouse capacity is both economical and efficient, the goods are properly kept (Gunasekaran, Marri and Menci 1999) and that these factors ultimately satisfy customer demands (Faber, de Koster and Smidts 2013). Planning as a warehouse management mechanism is proactive while control is reactive. Control is further described as the process of ensuring desired output. The authors support the idea that task complexity and market dynamics are the main drivers for warehouse management. The tactical planning horizon is affected by the dynamic environment of the warehousing organization and is consequently in the scope of days or weeks. An additional element in this perspective is the environment, which refers to the immediate external factors that are outside the control of the managers on a short-term perspective.

Pfohl, Zollner and Weber (1992) argue that the theory of economies of scale can be transferred to warehousing operations. The volume effect in economies of scale can be described as decreasing the average unit cost as a result of higher levels of output within a certain time period with given cost levels. Transferred to a warehouse setting, higher output with unchanged costs leads to increased capacity utilization, and thereby increased efficiency. Efficiency can be achieved by implementing order picking specialization, where the warehouse is

separated in different zones with employees responsible for different zones (Pfohl, Zollner and Weber 1992).

2.2 Warehousing

There is consensus in academic literature towards classifying manual, automated and automatic warehouse operations in four sequential processes: receiving, storage, order picking and shipping (Rouwenhorst et al. 2000; Gu, Goetschalckx and McGinnis 2007; Koster, Le-Duc and Roodbergen 2007; Faber, de Koster and Smidts 2013; van den Berg and Zijm 1999; Varila, Seppänen and Suomala 2007). Goods are delivered by trucks, which are unloaded at the receiving dock. Here, quantities are verified and sample tests performed in order to validate quality. Afterwards, temporary storage placement is allocated and inventory records are updated (Koster, Le-Duc and Roodbergen 2007). Even in cases where the warehouse itself is fully automatic, the process of receiving often includes some manual processes. The next step is to transport the product loads to the storage area. For documentation purposes, a label is attached to the item. If the internal storage modules i.e. pallets or boxes differ from the delivered goods then the loads must be reassembled in the storage area. When a product is requested, it must be retrieved from storage (order picking). An order lists products and quantities requested by a customer. When orders contain multiple SKUs then these must be accumulated and sorted before transportation to the shipping area (van den Berg and Zijm 1999). In the following sections, we will provide a more extensive review of the different warehouse processes, referred to as warehouse operations.

2.2.1 Storing

Transfer and put away of incoming products to its warehouse location can be classified as storing. This operation can include repackaging, e.g. full pallets to cases or standardized bins, and the physical movement from the receiving area to the different storing areas (Koster, Le-Duc and Roodbergen 2007). Because of this, storage can be viewed as a reverse order-picking situation. Order-picking and storing is both highlighted as complex (Faber, de Koster and Smidts 2013). To align the terminology of our thesis with academia, we follow the definitions of Koster, Le-Duc and Roodbergen (2007) regarding storage policies or assignment

methods e.g. forward-reserve allocation, full turnover storage and zoning. In this context, a storage assignment method is a set of rules that can be used to allocate products to storage locations.

2.2.2 Order picking

Order picking efficiency is derived from multiple factors such as human resources, internal reward systems, warehouse design, picking equipment, the type of the picked products and shape, size and type of the packaging (Saghir 2004). Order picking frequency and volume is driven by customer orders and therefore varies among industries and companies. Still, Won and Olafsson (2005) state that order picking operation consumes about 50% of all labor activities in a warehouse. A substantial amount of this activity time is used at traveling distances between products and aisles. According to Bartholdi and Hackman (2011) travel time can be classified as a non-value adding activity and therefore a first candidate for improvement. Koster, Le-Duc and Roodbergen (2007) found that the estimated cost of order picking corresponded to as much as 55% of total warehouse expenses. However, these figures differ in academia. For instance, van den Berg and Zijm (1999) state that order picking corresponds to more than 60% of all operating costs, while Coyle, Bardi and Langley (2002) broadens this to lie somewhere between 50-75% of total operating costs. The conclusion is however that the relatively large share of costs directed at order picking has deemed the operation a highly relevant area for cost to improve productivity. To operate efficiently, Koster, Le-Duc and Roodbergen (2007) suggest that the process need to be robustly designed and optimally controlled.

According to Goetschalckx and Ashayeri (1989) external factors, e.g. marketing channels, customer demand, supplier replenishment patterns and inventory levels influence the order-picking choices. Internal factors include warehouse characteristics, organization, and operational policies. It is however important to note that decision problems related to warehouse characteristics are often concerned at the warehousing design stage. In large warehouses, the pick volume is large and the available time window is short. A crucial aspect of efficiency is therefore to handle typical decision problems in design and control of

order picking processes by focusing on order batching, routing methods and zoning, optimal (internal) layout-design and storage assignment methods.

2.2.3 Order Batching

To operate effectively, it is essential to balance the tradeoff between warehouse efficiency and customer order urgency. Batching is a method for reducing the time customer orders are in the system, i.e. order holding time. Large batches cause long response time, and small batches are inefficient (Cachon and Terwiesch 2013). Consequently, both order picking time and order holding time need to be taken into account simultaneously (Won and Olafsson 2005). The problem may be formulated as follows: Given a random number of individual orders which also varies in size, and a constrained capacity, determine the minimum number of batches to be picked together to fulfill the orders. This is a modification of the classic so-called bin-packing problem (Johnson and Garey 1985). The warehouse order batching picking problem is therefore equivalent to finding the number of orders to batch that minimize the numbers of batches, and simultaneously not exceeding the capacity.

2.2.4 Warehouse routing methods

After the batches are defined, the order picking locations sequence must be determined. This decision is often defined and modeled as a traveling salesman's problem, i.e. route optimization (Daniels, Rummel and Schantz 1998; Won and Olafsson 2005). Given a fixed set of locations, the problem can be defined as finding the shortest route that visits each location exactly once, and starts and ends at the same location. Consequently, the order-picking problem is about determining the sequence of which locations to be visited in order to minimize total costs. Since the warehouse normally receives orders in variable frequency, but continuously, the planning problem must be solved quickly. The traveling salesman problem directs focus on the sequence of the visits in the storage in order to eliminate unnecessary travel time (Won and Olafsson 2005; Lawler et al. 1995). In firms such as wholesalers distributors and distribution warehouses, the task of processing orders is at the very core of the business (Petersen and Aase 2004). Because of the order frequency, small savings in order processing can

accumulate to significant savings. One strategy to handle the traveling salesman problem includes the approach of zone-picking and batching (Daniels, Rummel and Schantz 1998). In zone picking, the orders consisting of several products are assembled by multiple pickers assigned to different zones. The result of this is a traveling salesman's problem in smaller areas, which is easier to solve.

2.2.5 Heuristics

The objective of routing policies is often to sequence the items on a pick list and ensure a good route through the warehouse (Koster, Le-Duc and Roodbergen 2007). In this case, it can be sufficient to employ practical methods that do not guarantee optimality, but rather ensures the immediate goals defined as heuristics. Ackerman and Londe (1980) describe the warehousing setting as a dynamically changing and large work area. Aisles can be relocated and workers are mobile. Worker mobility and the large working arena make close supervision hard. In this setting, the authors state that one of the best heuristic tools in measuring travel distance is Pareto's law otherwise known as the 80-20 rule. The rule states that a majority of enterprises have 80% (or close to) of demand satisfied with 20% of the SKUs (Sanders 1987). Locating these closest to the shipping and receiving stations will reduce traveling distance and average order completion time. However, in most warehouses, goods are stored in product families (Ackerman and Londe 1980). Other routing heuristics are described by Roodbergen (2001) (attachment 2).

2.2.6 Packing and shipping

Following the definition by Saghir (2004), packaging is described as a coordinated system of preparing goods for safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery. Also, packaging has served as a medium for providing the customers with product information and promoting the products through the visual appearance i.e. marketing (Rod 1990). Further, packaging is recognized as an interface between the SC and the customers while being a multi-disciplinary issue that also requires qualitative analysis and methods. While not directly connected to warehouse operation, packing usually finds its place within the same building. The

warehouse managers must therefore seek to improve the costs associated with the amount or type of packaging material, while considering cost-effectiveness of transportation (Gunasekaran, Marri and Menci 1999). Packaging has a significant impact on the efficiency of logistical systems as it directly influences the time required for completing operations and delivery to customers (Twede 1992; Lockamy 1995). Saghir (2004) adds to the issue that increased packaging information could improve order filling time and labor costs. The system should consequently be designed to maximize customer and company value. Both Twede (1992) and Lockamy (1995) views packaging as a strategic decision that requires integration in the logistical plans in order to extract SC wide competitive advantages.

2.3 Comparative analysis

In order to develop an understanding of performing a comparative analysis, literature regarding benchmarking has been reviewed. According to Gu, Goetschalckx and McGinnis (2010), benchmarking represent the process of systematically assessing the performance of a warehouse by identifying inefficiencies, and proposing improvements based on the findings. The reason for conducting benchmarks is that it allows logistics professionals to learn from others and allows fresh ideas on how to improve operations and boost productivity (Cooke 1996). In order to conduct successful benchmarks, a mapping process of own logistics warehouse operations should be undertaken first. This may be a flow chart of operation activities, processes and costs. The purpose of the mapping is to provide in-depth insight on own operations. Then, decide how to measure performance and which measures to improve. The benchmark need to search for information that is meaningful to the specific context of the company (Cooke 1996). As a general rule, benchmarked organizations should be best-in-class actors in a comparable industry. The measures (quantitative data) provide indications on what is happening while the qualitative benchmark interprets the reasons behind the numbers. As identified by Hackman et al. (2001), traditional benchmarks has focused on comparing quantitative measures, such as operating costs (warehouse costs in percent of sales), operating productivity (units handled per person per hour) and response time/shipping accuracy. It could be important to

note that the author identified these as inaccurate measures for warehouse performance.

2.4 Model

Park and Webster (1989) propose model inputs for usage in warehouse systems. Suggested model elements include maximum inventory levels, number of storage aisles, picker travel time, labor cost and fuel costs. Total cost of different alternatives should be simulated. Park and Webster (1989) also argue that model results depend on storage structure, product demand patterns, control procedures and product arrival patterns. Amato et al. (2005) suggest a model of how to utilize the warehouse design, and suggest detailed model inputs with lengths, heights and capacities of the warehouse configuration. Rouwenhorst et al. (2000) argues that resources are critical factors in a warehouse model. They refer to resources as all means, personnel and equipment necessary to handle warehouse activities. Hackman et al. (2001) refers to critical resources as labor, space, storage and handling equipment. The different resources may be utilized in different ways, with different implications. Petersen and Aase (2004) categorize these resources in process decisions. They argued that several companies continue to use manual order picking due to variability in products shape and size. However, a model can help with determining how to pick, how to store, and how to route effectively. Petersen and Aase (2004) agrees with Park and Webster (1989) on model simulation inputs, but also suggests capacity of picking equipment, picking time per SKU, storage capacity, storing method, and that demand is based on the classical 80-20 distribution. They performed simulation experiments, and the result shows that batching has the largest impact on reducing total fulfilment time and in particular with small order sizes. While Rouwenhorst et al. (2000) discusses the isolated effect of different resources, Hackman et al. (2001) consider workload in addition to critical resources. Workload are how the practical challenges are solved in the warehouse, e.g. pallet picking, usage of cases, storage and order accumulation. They suggest a model with labor, space and equipment as input, and movement, storage and accumulation as output. When developing a model for application at ML, we need to use a combination of resource inputs, warehouse design inputs, labor, capacity, demand and costs. Also, activity based

costing has conceptually been applied to strengthen accuracy on assigning costs (Varila, Seppänen and Suomala 2007). This finding suggests building the warehouse model to consider activity based costing in order to receive comparable results.

2.5 Final considerations

MLs current configurations are created through organic development of their business (van de Ven and Poole 1995). They are specialized in performing logistic activities and distribution as part of their SC. Their role is wholesale, where the dealerships order goods. ML's responsibilities include receiving, storing, order picking, packing and distribution of the completed order back to its origination. With increased online sales, ML is in need of reorganize this setting to a flexible configuration. According to Lee (2004), flexible SCs should be agile, aligned and adjustable in addition to fast and cost-effective. This will help the corporation to secure competitive advantages. Agility refers to responding quickly to short term changes in demand. Alignment is defined as establishment of incentives for SC partners with the intent to improve chain-wide performance. Adaptability has the objective to adjust SC design to meet the requirements of market changes. By identifying the elements presented by Lee (2004) through the perspective of ML, we will be able to address flexibility. A high degree of flexibility will allow ML to swiftly implement and handle necessary changes in order to enable strategic success.

2.6 Theoretical relevance of the thesis

The introduction of EC will radically change the logistics of the SC and lead to a drastic change in inventory management (van den Berg and Zijm 1999). Facing future market trends, in particular the increased use of electronic media, the integration of inventory and warehouse management issues may prove to be a promising research area.

A descriptive analysis of warehouse operations could be beneficial for future researchers seeking relevant frameworks for comparable supply and value chains. For ML, the analysis is valuable for understanding and communicating a holistic visualization of warehouse operations. For scholars and other academic

readers, the thesis handles a highly relevant business issue. Companies are exploring online strategies and consequently re-aligning their SCs. We are experiencing a shift from existing and mature industries to new and potentially rapid growth channels. The thesis will improve academic insight of dual sales strategies with different customer segments in the spare parts industry. The SC may be in a process of change, from old and profitable to new (in growth). In this shift, there is a time that both strategies need to be maintained in order to be profitable. The online sales channel may end up being the dominant in the future, but today it is seen as a supplement.

The comparative analysis is likely to investigate actors with an above average technology level. This includes fully automatic warehouse operations by the utilization of robot technology. Performance metrics on this technology can help decision makers. Additionally, these metrics may inspire other innovative engineers to create superior products.

Hackman et al. (2001) identified that traditional benchmarks has focused on comparing quantitative measures such as operating costs, operating productivity and response time and shipping accuracy. They argue that these measures are inaccurate for warehouse performance because of the following reasons: 1) Operating costs varies directly and widely with product pricing and sales volumes, aspects outside the control of warehouse management. 2) Operating productivity implicitly view labor as the only resource in the facility. Space and capital investment in material handling and storage systems are ignored. 3) Units handled per person per hour view this measure as the only output of the facility. Nevertheless, “units” vary in required handling time per unit. As a result, meaningful comparisons are restricted to products with similarities. For this thesis, we will need an approach to a comparative analysis that considers several dimensions of warehouse performance and thus makes comparisons of warehouses across a broader spectrum possible. The exercise provides learning through both the internal mapping process and the comparison with another actor.

Existing mathematical warehouse models are identified to be too general in their approach. This results in models with little or no practical application for specific cases. Therefore, our model will contribute on the area of the specific

case; how to reconfigure warehouse operations in order to handle a shift in the nature of customer orders.

3.0 Research methodology

Research methodology relates to the overarching approach to the complete process of doing research. Choosing the appropriate methodology is essential in order to be able to generate correct and valid answers, and contributes to systematically solving of the research question (Kothari 2004).

3.1 Research strategy

Research strategy refers to the general orientation of conducting business research (Bryman and Bell 2011). Research in management has historically been positivistic, and correspondingly quantitatively oriented on a linear deductive path, but is changing towards a realist perspective which may be called more practitioner oriented (Riege 2003). Qualitative research is constructed as a research strategy that emphasizes words rather than quantification and computation of data. Quantitative research utilizes numbers, values and calculations in order to conclude on results (Bryman and Bell 2011). As this research aims to map the current operations at ML, the corresponding performance, and simulate changes in input and output, a combination of the two research strategies will be utilized. The chosen research strategy of this thesis combines both qualitative and quantitative methods and could thus be defined as a mixed method research (Östlund et al. 2011).

Qualitative data may contribute towards increased knowledge regarding framing the research question. Additionally, data from qualitative methods might enable quantitative methods such as calculations and models. Quantitative data will be collected and analyzed with the intent of comparing and simulating results. Consequently, this research strategy will enable the authors to acquire in-depth understanding of the context, which permits a holistic perspective.

This thesis will use semi-structured and unstructured interviews, conceptual and computational frameworks and primary and secondary data to derive results. This adds up to a research methodology consistent with a deductive mixed methods approach (Bryman and Bell 2011). With a deductive position, the

purpose of data is to draw conclusions. Our main priority is related to quantitative data collection, while our sequence is concurrent qualitative and quantitative. Still, our intention is that qualitative research should serve as foundation for identifying themes or practical understanding of the nature of the problem. The numerical quantitative analysis will include internal company documents with overview of costs, lead times, product measurements, etc.

3.2 Research design

Research design is defined as the framework of collection and analysis of data (Bryman and Bell 2011). In traditional research methodology, analytical tools are classified in accordance with the distinguishing schools of qualitative and quantitative research. While it has been common to associate case studies with the qualitative world, Gary (2011) draws the attention towards neglecting this segregation and instead underpin the importance of a pragmatic approach characterized by analytical eclecticism. This is consistent with the philosophy of Stake (1978) who explained that the objectives of practical arts where, in all essence, to get things done. As the thesis share these characteristics, it is theorized that methods for collecting and analyzing data should be practically rather than theoretically oriented.

This thesis assumes the perspective of ML as a single entity and the reconfiguration issue and profitability aspect as a single problem. The objective of the thesis is to provide solutions for the problem in the form of feasible suggestions for implementation. Specific for the contextual setting of the case in question is the location, strategic event, organization, people, knowledge and implemented systems. Together these elements manifest a complex but observable phenomenon.

According to Gerring (2007) research of a single and comprehensive phenomenon, in a naturalistic setting, where case and context are difficult to distinguish and where the research require triangulation of evidence, can be classified as a case study. Eisenhardt (1989) argues that case studies serves as the necessary research strategy for understanding the dynamics present within a single setting, and is further recommended by Normann (1980) for studies of complex systems where broad conceptual frameworks are applied. Such studies can also be

applied to aggregated systems, such as a network, relationship, resource or a SC (Bryman and Bell 2011). According to Woodside (2010) the major objectives of a case study can be any combination of description, understanding, prediction or control where the principal objective for the researchers is to acquire deep understanding of the actors, interactions, sentiments and behaviors that occur in processes.

The thesis is written in conjunction with the launch of the “EC 2016 commitment project”. In this setting, the researchers will work in parallel with the project as it develops. When the researchers have little control over the events, the contemporary phenomenon can be studied with an objective, in-depth case study examination (Yin 2014; McCutcheon and Meredith 1993). Because the researchers want to develop a clear picture of the phenomenon, a case study covers a large amount of data collected within the organization. The primary sources of data come from direct observations and interviews with involved people. Secondary data can in turn be described as documents and previous records from other authors. Case studies are distinct from historical studies and focuses on current conditions, utilizing historical data mainly to understand the information gathered about the ongoing situation (McCutcheon and Meredith 1993). Also, case studies generally exclude influencing capabilities by the researchers (McCutcheon and Meredith 1993).

In case studies, general quantitative methods include model building and simulations (Ellram 1996), while the naturalistic lens used to observe the phenomenon belongs to qualitative research (Bryman and Bell 2011). As defined by Stake (1995), the nature of the case study is intrinsic, where a case in itself proposes the research of interest. Based on this classification, the research methods will differ from other categorizations (Simons 2009). According to Flyvbjerg (2006), the combinatory approach of a case study will more often than not allow greater flexibility and enhance the depth of analysis to an extent beyond that of the traditional research methods. Similarly, Rowley (2002) writes that case studies may offer insights that may be unachievable by other research strategies and approaches. Conclusively, we believe that a mixed-method single case study serves as the appropriate design for the aforementioned research question.

3.3 Data collection

Research method is related to the conduct of data collection. The data collection is one of the main assignments for processing data and deriving results. To enable the building of a model, both primary and secondary data must be explored. In order to deliver a suiting model, understanding of the contextual setting is important. Therefore, the first step in the data collection will be to map the current setting. The first data collection phase thus have a descriptive nature (Yin 2014). For comparative purposes, it is pivotal to gain access and extract relevant data of another SC configuration.

3.3.1 Method

To answer our research question, we have identified the following chronological process flowchart that are attributed strategic value to our overarching question (see also attachment 3).

1. Mapping of current warehouse operations (traditional and EC): In order to re-organize today's operations at the warehouse, understanding of the current setting is essential. The first step is therefore to map the processes, including the warehouse operations generated from the traditional sales strategy, and the online sales strategy. The mapping will address the issue from orders received, through picking and packing of goods, to related distribution and transport. All relevant value chain processes and corresponding key metrics will be identified.

2. Analysis of a leading E-commerce actor: Different EC actors who are performing warehouse activities organize their warehouse operations in various ways. In order to understand the broad variation in design, a comparative analysis of an EC actor will be performed. This analysis will be cursory in the pursuit of best practice.

3. Comparative analysis: The comparison will investigate duplication of elements in the different actors' configurations, and if there exist a "best practice". This section will provide analysis of cost figures, lead times, service level and other valuable metrics.

4. Model development: In order to simulate reconfigurations on warehouse operations, a model will be developed. As defined by Hornby (2000), a model is a

description of a system which is used for explaining how something works or calculating what might happen. The model building will be based on the mapping of MLs current setting. The result will be a simulation tool, with fixed and variable factors, which given a set of input, grants measure of resource levels. The model handles effects on costs, space consumption, time and service.

5. *Simulate performance effects*: Based on the comparison, suggested re-configurations will be simulated in a model. The model will deal with costs, service levels, lead times and space as outputs. Measures regarding performance and strategic goal achievement will be addressed.

6. *Re-configure warehouse operations at ML*: Based on the simulation, re-configurations will be suggested. This is application of the identified best practice. An investigation of the feasibility of the proposed reconfiguration will be conducted before recommendations are presented to ML.

3.3.2 Secondary data

Secondary data consists of data collected in the past or by others (Bryman and Bell 2011). Data available online, in journals and books all fall into this category. We will strive to use academic articles and books as a framework for our analysis. In situations where academic research serves as inadequate sources of information, we will seek to use secondary data from credible online institutions (e.g. the Norwegian SSB). Only in the case where there are no available or obtainable data from these sources, we will consult other resources e.g. PowerPoint lecture material and online encyclopedias. Such resources can be useful as a starting point for exploring new topics when little is known about the field (Chesney 2006).

Our purpose is to adapt and apply existing models or elements from these data sources to a new case setting. It is important that the warehouse organization and configuration account for ripple effects in the total SC so that sub-optimal solutions are avoided. For assessing SC configurations, we need to review SC management and value chain literature and theory. Still, warehouse management, operations and logistics will be the primary target for knowledge acquisition. In order to develop a feasible and quantitative model and simulation tool, it is beneficial to extract theory from similar cases and from existing frameworks.

The comparative analysis will be derived from a mixed type of collective data. The provision of the data will be collected through existing sources, where the material is already available. However, we believe some degree of personal involvement and development might be necessary to achieve understanding of other relevant actors' warehouse configurations, and the obtaining of "hard data" as basis for comparison. This data is likely to be collected either by interviews, conducted personally or by telephone.

3.3.3 Primary data

Primary data is input collected by the researchers (Bryman and Bell 2011). This is data acquired by first-hand experience, investigations and collected with regard to the specific surroundings in the case in order to understand the underlying mechanisms in the phenomenon (McCutcheon and Meredith 1993). The nature of a large share of the data may come from the surroundings itself and the atmosphere at the company. Such data collection can be described as absorption of data enabled by the researcher's presence. The contribution will be in the form of unprocessed raw data available for interpretation.

In order to map the current operations at ML, observations and participation of the daily operations will be undertaken. The purpose of this endeavor is a thoroughly understanding of the problem. Supplementing information will be documents, empirical data from ML, order statistics, figures on costs and sales, and other sources that contribute to a clear understanding. Development of own calculations and computations will be derived from internal company files, sheets, documents and meetings with key personnel. Access to MLs internal database and ERP-system has been granted. Primary data is therefore likely to consist of provided and developed excel files, data files from the IT-system (Astro) and resources within the company in question. In addition, semi-structured interviews with company co-workers, managers, technical staff and head of EC will be conducted. The semi-structured format ensures coverage of the necessary key points. However, the interviews will have an open-ended structure, allowing the interviewer to explore areas that comes to lights during the dialogue (McCutcheon and Meredith 1993). The purpose of the interviews is to identify and map the current warehouse processes, activities and flows in order to

understand the structure of the challenge ML faces. Hopefully, the interviews will reveal critical processes in the total warehouse system. It is interesting to know where the bottleneck may be, where there is slack in the system, and where the critical processes are located.

With regard to the development of the simulation model, both academic sources and company specific data will serve as the foundation. Input data will be both fixed and variable factors. Interviews will function as a basis for which outputs are desired to gain from the model. Amato et al. (2005) suggests model inputs such as rack length (meters), rack height (meters), time to reach the horizontal end of the rack (min) from the retrieve location to the storage, etc. to serve as the models fixed variables. The input to the model will be developed in collaboration with ML in order to ensure right quantification of reality. Because every theoretical model is a simplification of reality (Pastor 2000), the utilization of communication with the focal company are essential in order to provide a model with practical feasibility and relevance.

3.3.4 Data analysis

When the collection of both secondary and primary data is completed, the researchers must understand, interpret, explain and decode the information (Bryman and Bell 2011). This is analysis of MLs current operations, analysis of another actors operations, comparison and model development. The main task of the data analysis is the comparison of MLs current configuration, which will serve as a foundation for the simulation model. As this thesis's main objective is to suggest re-organizing of warehouse operations and accompanying distribution, the analysis aim to identify relevant variables and possible warehouse adjustments. These identified variables are to be used in our model in order to simulate increased EC sales and effects of warehouse operations. Based on the output data from the model, analyses of costs, time, service and distribution will be calculated before suggesting new configurations at ML, which may be implemented under a given set of circumstances.

Triangulation as overarching approach is applied. This is the usage of different modes of data collection to assure cross validation (Jick 1979). Interviews, observation and experience based data calculations contribute to the

overall objective in the study. However, in order to understand the complex problem, several aspects of MLs activities need to be studied. Consequently, different collective modes are necessary.

3.4 Quality of the research

In order to ensure quality of the research, three of the most prominent criteria for evaluation are reliability, replication and validity (Bryman and Bell 2011). Stability and quality of the obtained qualitative data is determined by testing validity and reliability (Riege 2003). However, there is no single set of consistent validity and reliability tests for each research phase available in literature.

3.4.1 Replicability and reliability

Reliability and replicability are very similar and concerns questions regarding the repeatability of the study, the consistency of measurements, and to what extent the findings can be trusted (Bryman and Bell 2011). Replicability refers to the repeatability of the methods used in the study, and thus whether the study can be re-created. Reliability is conceptually slightly different and concerns the consistency of the findings. Where it is possible, findings, observations and conclusions from multiple researchers will be utilized. Congruence will be addressed through a discussion of applicable models.

As a supplement to this thesis, a case study protocol and a database will be developed. In case studies, a case study protocol can be used to address replicability while a case study database could serve the purpose of enhancing reliability (Ellram 1996). The protocol should include interview-guides as well as the procedures to follow in using the test instruments. When involving multiple data sources, a case study database should include all printed material provided by participants as well as copies of completed interviews, with notes and summaries (Ellram 1996).

The case study protocol for this thesis will include semi-structured interview guides. The procedures to follow will be handled as an attachment and will generally consist of an agenda or bullet-points corresponding with questions or topics to be discussed. In order to prepare participants for interviews, we will provide introductory information by E-mail or telephone. For the simulation

model, restrictions and assumptions will be explained to avoid ambiguity. In the case study database, written summaries of each interview will be provided. All secondary data material will be stored and clustered according to function in a temporary database. To avoid copyright issues, journal articles, books and other externally owned data sources will not be included in this database. Instead, other researchers need to consult the reference guide provided at the end of the thesis. Internal company data used as a foundation for acquiring key knowledge will be included with the exception of sensitive information. Observable data used in the description of SC activities as well as empirical quantitative data will be recorded.

3.4.2 Validity

Validity relates to how a measurement captures what it is supposed to measure (Bryman and Bell 2011), and is related to the integrity of the conclusions that is generated from research. Validation and verification of data is important to ensure quality and reliable results. Ellram (1996) divided validity in three categories i.e. construct validity, internal validity and external validity. In this section, we will review these concepts and present their implications for our research.

Construct validity is closely tied to reliability and replicability. The concept revolves around identifying and establishing proper measures for the studied phenomenon (Yin 2014) and should consequently be associated with the data collection phase. To ensure construct validity we will follow the recommendations by Gibbert and Ruigrok (2010); to develop a chain of evidence and pursue to use multiple sources of information. Additionally, having key informants review the case study research is seen as an important element in establishing valid measures (Ellram 1996; Gibbert and Ruigrok 2010). Two other thesis-writing groups have agreed to assess and review our research. Fresh perspectives can help counteract single-minded thinking through added critique and reflection around measure efforts. Our peer's primary supplementing assignment will be to ensure consistency of our theoretical propositions. Similarly, representatives from ML are interested in reviewing the thesis to ensure quality and usability for own operations. We expect this review to assess rigor (i.e. accuracy) of measurements as well as ensuring relevance of the practical perspective.

Internal validity or credibility mostly concerns explanatory case studies where researchers are trying to demonstrate cause and effect by an independent variable (Yin 2014). In a broader perspective, and thus applicable to this study, internal validity extends to making proper inferences. Analytical techniques that address this issue are: pattern matching, explanation building, addressing rival explanations and using logic models (Yin 2014). Pattern matching compares an empirical configuration with a prediction preceding data collection. The procedure bears several similar characteristics of hypothesis testing but is more broadly defined. Similar patterns strengthen internal validity (Trochim 1989). Explanation building is likely to be an iterative process consisting of making an initial theoretical statement and comparing findings and details of the case against a statement proposition. Logic models can be used to visualize and clarify vision and goals as well as how the sequence of actions will accomplish these goals.

External validity reflects how accurately the results represent the phenomenon studied and concerns generalizability of results. Lack of generalizability has been a major criticism of case studies (Ellram 1996). Single case studies may seem a poor basis for generalization, but such research is studied at length and in depth. It might be inexpedient to seek and derive completely new learning from case studies. Instead, refined understanding of a internalized reality might be reached (Stake 1995). However, case studies may, in some situations, serve as the preferred method of research for readers with aligned epistemological perspective. In this instance the case study in itself proposes a natural basis for generalization (Stake 1978). Our findings can serve as a basis for other researchers and be utilized in other analyses in similar settings. Still, this study is a result of a specific context and with a specific content, and thus, while generalizable to a theoretical proposition, it is hard to fully generalize for universes or populations (Bryman and Bell 2011; Ellram 1996).

This specific case study is particularly relevant in this present of time, due to the current market situation, access to technology, modes of transportation and available resources. To validate our academic sources, high quality sources will be used. This is classification of articles based on number of citations, the journals classification or publisher's web page for impact factor, scope or field of study and quartile rankings. Regarding the validation of secondary data from internal

sources in the company, we will check for inconsistencies found in the sources. The primary tool for ascertaining data relevance will be to triangulate with company representatives. If necessary, the data must be brought up to date with relevant numbers, facts and considerations using own research and investigation.

Interviews will be conducted with the intent of understanding underlying structures of the problem. In order to validate our primary data we will use semi-structured interview triangulation. The researchers will take notes and observe the interviewees. We will follow Bryman and Bell (2011) approach to rewrite the dialogue with own words, and send the document back to the interviewee for verification. In our interview setting, the research object will be asked questions, but also given the opportunity to talk freely.

4.0 Project plan

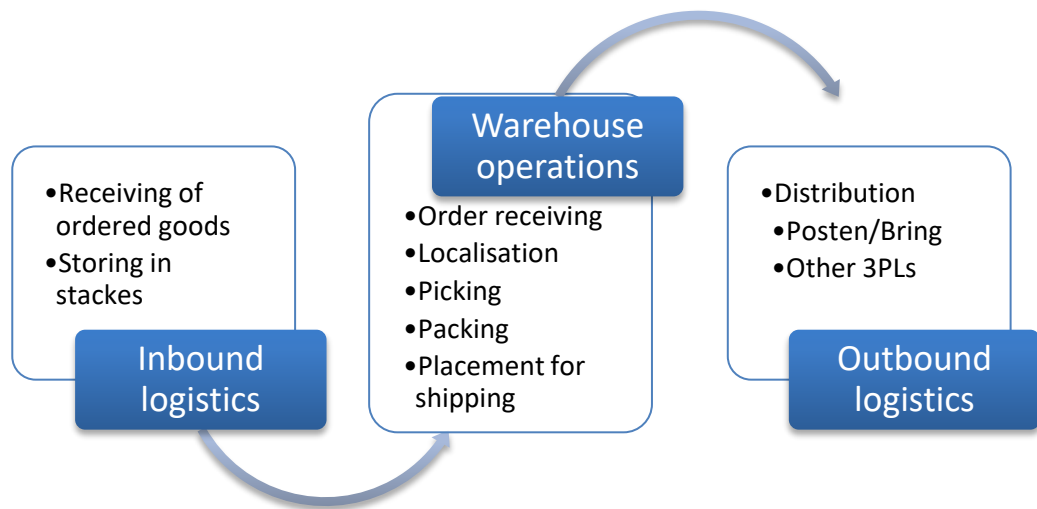
We are in close dialogue with ML in order to align goals, set up our working environment and create a basis for our analysis. They are interested in our thesis, and that is an ensuring factor when it comes to access to information.

4.1 Future time disposition

The researchers has developed the project plan in attachment 4, with a guiding function. The different activities are necessary in order to deliver our thesis in time. However, the plan is not tentative. A new EC manager starts working at ML from 1.1.2016. As both the leaders and the project are under development, we expect that some slack is needed for the plan itself. Thus, the project plan will be updated with new information.

5.0 Attachments

5.1 Attachment 1: Current warehouse setting



5.2 Attachment 2: Routing heuristics

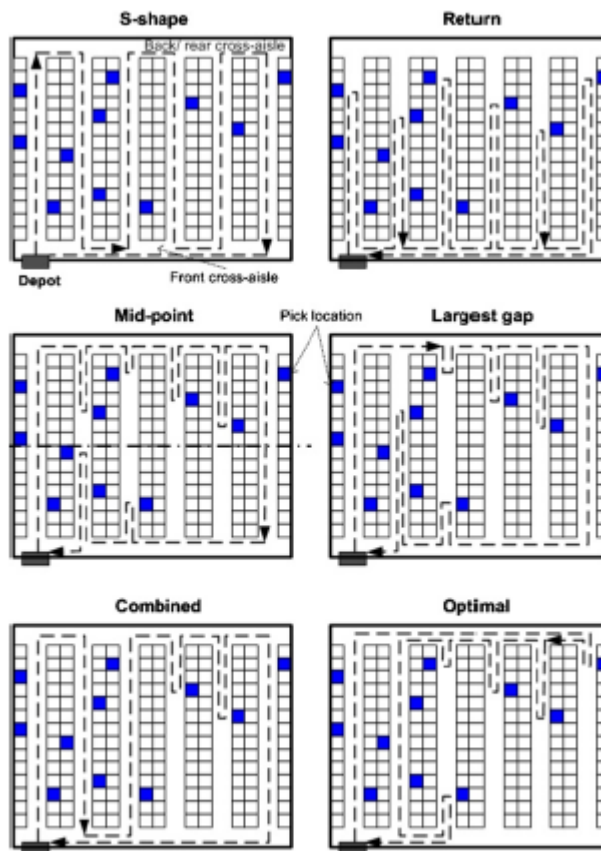


Fig. 8. Example of a number of routing methods for a single-block warehouse (Roodbergen, 2001).

Model extracted from: (Roodbergen 2001).

5.3 Attachment 3: Process flowchart



5.4 Attachment 4: Project plan

	Jan	Feb	March	April	May	June	July	Aug	Sep
Deliver preliminary	Yellow								
Primarily data collection		Green	Green	Green					
Data analysis		Blue	Blue	Blue					
Secondary data collection			Olive	Olive	Olive				
Processing data			Red	Red	Red	Red			
Thesis writing			Dark Blue	Dark Blue	Dark Blue	Dark Blue	Dark Blue		
Finished 1st draft						Teal	Teal		
Finished 2nd draft							Yellow	Yellow	
Supervisor reading/editing								Purple	Purple
Deliver date 1.sept									Teal

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