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A proposal for reducing the average inventory during an expansion

A case study of the e-commerce actor Jollyroom

Master's Thesis in the Master's Programme Supply Chain Management

DAVID PETERSSON
OSCAR TREUTIGER

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
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David Petersson
Oscar Treutiger

Tutor, Chalmers: Per-Olof Arnäs
Tutor, company: Johan Kittel

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Department of Technology Management and Economics
Division of Service Management and Logistics
Chalmers University of Technology
SE-412 96 Gothenburg, Sweden
Telephone: + 46 (0)31-772 1000

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ABSTRACT

The e-commerce industry has during the last decade seen a steady growth where the same distribution channel is becoming more integrated with its customers' life. With the rapid growth the industry has seen, it has brought some issues to life where some are linked to the ability of handling scalability. The report aimed to handle the operational scalability and more specifically, how to reduce the average inventory and tied up capital. The studied company in this report's case is Jollyroom, a fast-growing organisation and from March (2017) also the market leader in its segment. The organisation has since its launch in 2010 increased its turnover by approximately 100% each year, and the warehouse space needed has increased from one building to three. The organisation has reached an impasse where additional warehouse space is needed if they keep current operations in play.

The report utilises the approach of structuring the purchasing operations by applying an economic order quantity to identify lot sizes and the cycle service safety stock to make sure there are products available when they are demanded by customers. This fairly simple approach results in a 55% reduction of the average inventory, a 52% increase of the inventory turnover, a 25% decrease in tied up capital, and a reduction of 32% in inventory carrying costs.

Keywords: Inventory management, Scalability, Lot sizing, ABC-classification, Process mapping

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David Petersson & Oscar Treutiger

TABLE OF CONTENTS

List of figures

List of tables

1. INTRODUCTION

In the following chapter an introduction to the issues studied in the report are given and presented. Additionally, the purpose is presented with the linked research questions used to reach it.

1.1 Background

The e-commerce market in Europe is becoming more and more mature with increasing turnover (Postnord, 2016). As the number of actors are increasing on the market and shopping online now is in a normalised state for consumers, actors need to differentiate themselves by other means than only its carried products (*ibid)*. Actors are, in the same report, advised to cooperate with a logistics partner to aid in distribution on as many markets as possible (*ibid)*. In other words, a logistics partner that is able to scale its operations as an actor's need for distribution varies.

Other issues regarding scalability, defined as "*The capacity to be changed in size or scale"* (Oxford dictionaries, n.d), raised in the earlier years of e-commerce (2000-2004) are linked to software and how a website is to tackle increasing amounts of users on an actor's website (Cho & Kim, 2004; Menasce, 2000; Sarwar, Karypis, Konstan & Riedl, 2000). Menasce (2000) refers to the increase of visitors on a website while Cho and Kim (2004) and Sarwar et al. (2002) links the scalability issue to the increase of products ranging on the websites. As the assortment of products increase, the harder it is for customers to find what they are looking for (Cho & Kim, 2004; Sarwar et al., 2002). This leads to increased pressure on the software analysing patterns and making recommendations to customers to find what they might be looking for (*ibid*).

As is mentioned by de Koster (2001) an e-commerce actor, with a specific warehouse to fulfil internet orders, needs to build volume and assortment in order to fulfil customer orders. Thus leading to the importance of understanding the operational scalability with increasing assortment and volume.

This is an issue identified at the Swedish e-commerce actor Jollyroom who since the launch in 2010 has grown rapidly. Jollyroom is a Swedish e-commerce actor that offers a large assortment of children and baby products and is expected to pass 1 billion in turnover during the year of 2017[1]. The products that Jollyroom offer are mainly targeted to fit children aged 0-12 years, although a complete assortment is also offered to pregnant women. The fast growth has resulted in several challenges. During the first years, Jollyroom's office and warehouse were located in Mölndal, just outside of Gothenburg. In the beginning of 2014 the company performed a relocation due to space limitations and moved into a new larger facility north of Gothenburg in Hisings Kärra. Since then, two additional warehouses have come into use through lease agreements and they are now using a total warehouse space that equals about 30 000 square meters.

It is expected that Jollyroom's growth will continue which is why the company now has started to look for alternative solutions, involving an even larger facility and the possibility of increasing the level of automation. However, these are plans that cannot be realised in the near future which is why there is a need of improving their current way of working and make use of resources that are already available. Jollyroom has therefore expressed an interest and a need of mapping, evaluating and presenting proposals for improvement regarding some processes, mainly the ones that are linked to the inbound logistics and warehouse operations. This background about the company and its present circumstances leads into the purpose of the project, which is outlined below.

1.2 Scope of the report

During the seven years Jollyroom has been a part of the e-commerce market they have had almost a 100% growth each year. This has meant that many changes has been made involving the facilities, the organisation and the way of working. As for many other rapidly expanding companies, there are tendencies that the processes are not always keeping up with the growth.

As previously mentioned, Jollyroom is expected to pass one billion in turnover during 2017[2]. If looking another three years into the future the company sees a continued

[1] Purchasing manager (Jollyroom). Interviewed by the authors 2017-02-07

strong growth and forecasts a turnover of two billion SEK during 2020[1]. The range of articles offered will increase and hence a larger amount of SKUs will be stored. To handle these challenges, Jollyroom is currently evaluating the opportunities to consolidate the three warehouses into one new facility where automation will have a more central part[1]. However, until this can be realised the increasing requirements of warehouse space remains a critical issue and there will instead be a need of making the processes more efficient.

1.2.1 Purpose

The purpose of the report is to identify how the focal company, currently suffering from scalability issues, can improve and make the current logistics setup more efficient and flexible before the investment in a new warehouse.

In order to understand current situation and how the focal company is affected by scalability, below research question is formulated.

- RQ1: *What are the key logistical processes and how are they affected by scalability at the focal company?*

Based on knowledge gathered from identifying the key logistical processes in RQ1 it is possible to determine which process or processes to focus on. Based on the assumption that the focal company continues to grow, the below research question is formulated in order to identify means on how to tackle the growth.

- RQ2: *How can the efficiency of the logistical processes be maintained or increased while the company is growing?*

1.2.2 Limitations

As the report is focused on scalability at the focal company, it is important to note that the studied section of scalability is in building volume and assortment. Hence there are no studies performed regarding software based scalability nor the distributor selection of scalability mentioned in chapter 1.1. The results from this report is hence focused on the inbound deliveries of goods and warehouse operations. In order to not disclose sensitive company information some data is only presented as changes in percentages.

2. METHODOLOGY

The following chapter presents approaches and methods used in the report where arguments for and against the selected methods are presented. The chapter describes how the data was collected and how it was used, and finally argues for the report's validity and reliability.

2.1 Research design

As the report was based upon the mapping of processes at Jollyroom, an e-commerce actor, the research was conducted in an iterative and inductive matter. Meaning that the report was built from observations and interviews (Bryman & Bell, 2003).

In the book of Bryman and Bell (2003) the distinction between quantitative and qualitative research mainly depends on the format of the collected data and the analysis of the data. Quantitative data is referred to as quantifiable and/or measurable data, while the qualitative data often comes in forms of words (Bryman & Bell, 2003). In order for the report and issues presented to be easy to understand as well as understanding the reasoning behind them, the report utilised multi-strategy research, a combination of both quantitative and qualitative research. By combining the strategies, the collected data can be approached as triangulative, where the different collected data sets can validate each other (Eisenhardt, 1989) (Bryman & Bell, 2003).

2.1.1 Case Study

According to Yin (2009) a case study research strategy is when the research is performed to understand a certain complex context, where the research questions are based on the questions why and how. As is mentioned, these questions similarly match the strategy of the historical method, but a case study strategy includes empirical data from direct observations and interviews of subjects within the studied case (Yin, 2009). Interviews and observations within the studied case were required as the report was based on empirical data from one organisation, hence the report fits the parameters of a case study (Bryman & Bell, 2003) (Yin, 2009). As is argued by Bryman and Bell (2003) there are some issues regarding generalisability of the findings when using a case study as a research design. However, as is argued by Yin (2009) the goal is to generalise a theory and not statistically prove it. The report therefore provides a section of generalisable findings from secondary sources as well as case specific findings.

2.2 Research process

The research process of the report can be divided in four phases, visualised in figure 1, below. Yin (2009) argues that a theoretical study is essential to perform before any empirical data collection, however, Eisenhardt (1989) argues for the importance of avoiding to consider links between theory and empirical findings as these can limit or provide a biased perspective.

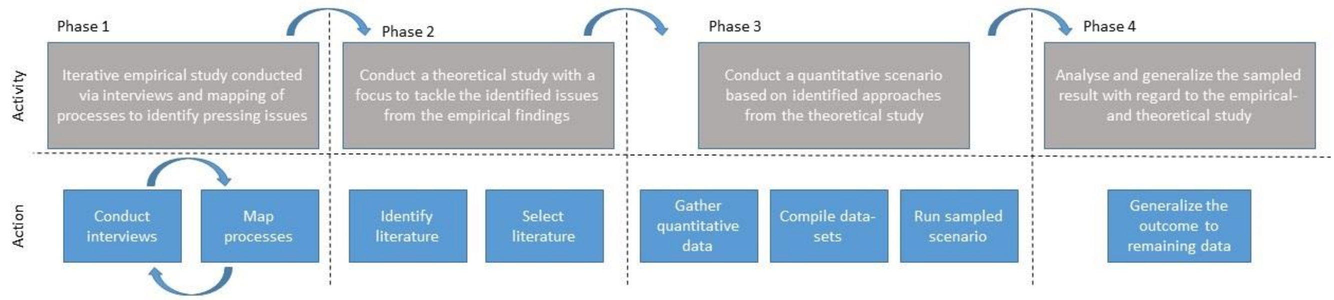

Figure 1. Visualisation of the report's research process

The four phases were based on the main activities of the report linked with sub processes below. To note is that Phase 1, 2 and 3 were conducted iteratively.

In *Phase 1* the foundation of the report was identified. The data collection of phase 1 was mainly qualitative data from structured and unstructured interviews with employees at the focal company from different departments with different responsibilities. The reasoning behind the arrows going back and forth between 'Conduct interviews' and 'Map processes' is because of the top down approach used. The first interviews with the different departments were with a manager of the department. The interviews and mapping of processes started wide in order to get familiarised with the organisation and the different departments to identify and evaluate a following line of questions before the next interview opportunity.

The following interviews were conducted with section managers, such as purchasing category managers and managers for different sections of the warehouse operations.

As the understanding for the processes in the different sections expanded, so did the process maps, mainly due to a more detailed line of questioning. The final interviews were held with team leaders in the warehouse and category managers regarding more specific processes.

In *Phase 2* a theoretical study was performed with a focus on the issues stated from interviewees and what was identified from the mapping.

Phase 3 consisted of data collection and a built scenario based on the theoretical study. In this phase, quantitative data, was requested in order to fit the theoretical framework. The data was sorted and sampled based on previous knowledge, both in regards to the process mapping and the theoretical study. Once the data was compiled in accordance to the theoretical study, a scenario was built.

In *Phase 4* the results from the scenario was analysed and compared with the previous state. The analysis was also performed and evaluated against the change's impact on the mapped processes.

2.3 Data collection methods

As the research design of the report was of a multi-strategy character with a triangulation approach, the report utilised methods of data collection such as interviews with employees and managers, internal documents, and from observations of the operations in the warehouse environment as well as the purchasing operations.

2.3.1 Interviews

Interviews were conducted with employees and managers in both unstructured and semi-structured manners. Unstructured and semi-structured interviews provide flexibility in this method of data collection (Bryman & Bell, 2003). It simplifies elaboration on recently discussed topics, as well as new questions related to the topic or observations made during the interview. In order to not misinterpret or document data from the interviews with a biased angle, all semi-structured interviews were voice-recorded. The unstructured interviews were mainly used to confirm or to specify on statements said or done during the semi-structured interviews. The unstructured interviews were held with the same persons as was interviewed in a semi-structured manner. A list of the held semi-structured interviews is listed below in table 1. The semi-structured interviews were held with one interviewee per session in order to receive the interviewees personal and professional opinion on the points of interest. The line of questions was initially wide and later further specified towards certain processes. For instance, the purchasing related questions were referring to their role in the organisation and a generalised description of a purchasing activity, and later specified towards more detailed descriptions of the processes mentioned.

Table 1. Table on conducted semi-structured interviews sorted in a descending order.

#	Department	Role	Date
1	Warehouse operations	Warehouse manager	2017-02-01
2	Purchasing	Purchasing manager	2017-02-07
3	Warehouse operations	Claims and Returns manager	2017-02-08
4	Purchasing	Category purchasing manager (1)	2017-02-17
5	Purchasing	Category purchasing manager (2)	2017-02-17
6	Purchasing	Category purchasing manager (3)	2017-02-17
7	Purchasing	Category purchasing manager (4)	2017-02-17
8	Warehouse operations	Inbound deliveries manager	2017-02-28
9	Purchasing	Category purchasing manager (3)	2017-03-08
10	Purchasing	Category purchasing manager (2)	2017-03-09
11	Purchasing	Category purchasing manager (4)	2017-03-09
12	Warehouse operations	Inbound deliveries controller	2017-03-16
13	Warehouse operations	Outbound deliveries team leader	2017-03-24
14	Warehouse operations	Inbound deliveries team leader	2017-03-27
15	Shipping partner	Key account manager	2017-04-20

2.3.2 Internal documents

Internal documents are according to Bryman and Bell (2003) a good way to get good background information of an organisation. The use of internal documents in this report was mainly linked to the organisation's ERP system and the empirical data retrieved from it. The data requested was aimed to quantify and strengthen the qualitative data received during interviews and observations. As such, in order to get a yearly picture of Jollyroom’s activities, data from 2016 was requested. As the data for each material number/SKU was deemed necessary, the following data was requested; all linked movement types; quantities in each movement type; dates of when the movement was performed; volume of each material number; stock balance at the beginning of year as well as at the end of the year; the moving average purchasing price of the material number; and an inventory carrying cost per time unit.

The movement types with quantities and dates explains how the material was handled internally, as the outgoing goods was one movement type, ingoing goods was one movement type, goods returned from customers in resalable condition was one movement type etc. The movement type data was used to illustrate what the stock balance looked like during the year, as SAP was unable to retrieve this. The moving average of the purchasing price for the materials was requested to get a relatively accurate figure to represent the yearly price. The inventory carrying cost per time unit however was more difficult to retrieve as this was not used or updated as often as the other parameters. Instead, the inventory carrying cost per time unit was calculated based on the total warehousing cost per month, and the average number of articles kept in stock during 2016.

Data requested from other instances than the ERP-system was the average number of articles retrieved in one TEU and the historic price data of shipping a container from Asia to Europe. The data regarding articles in one TEU was requested from the Warehouse manager, and the historical container shipping prices from Jollyroom’s shipping partner.

2.3.3 Observations

Observations of operations performed in the warehouse was an important part of the report as this identified the different processes and flows in the mapping of processes. Observations in combination with unstructured interviews lead to further understanding of contexts and how and why a process is designed to be performed as it is. Using observation as a data gathering tool can easily validate what has been said during interviews. There are however some issues to consider when one uses observations as a mean of gathering data. Such issues are for instance in the sampling stage where one needs to consider who it is that is being observed and when in time the observations are occurring. The use of the observations were hence to aid in process mapping by validating data given during interviews as well as identify new data not mentioned during the interviews.

2.4 Literature review

In order to find relevant and published literature, the main search engines used were the Chalmers Library (Summon) and Google Scholar. When the search for journals and articles were performed, certain aspects were considered. Such as Jollyrooms context and the aim of the report, namely scalability within warehousing processes. Search words used were for instance: “Scalability”, “E-commerce”, “Warehouse management”, and “Inventory management”. Above search words and others were used in several different combinations.

2.5 Analysis of results

The results of the report were analysed based on the findings of the process-mapping and the ABC-classification with a lot size focused purchasing activity.

2.5.1 Process mapping

In order to better visualise and understand how an organisation’s processes are interconnected and dependent on one and another as well as aid in identification of process improvement, process mapping is a viable tool (Damelio, 1996). While utilising a process map one can also identify the key features in the relationships of processes (Damelio, 2011).

As is stated above, process mapping helps in identifying the flow of goods/processes and create a bigger picture of an organisation regarding what happens where and eventually why. The process mapping in this report aimed to identify what the processes at Jollyroom looked like and how they were interconnected. Based from the aim of performing process mapping, a literature search was conducted in order to find some input on how it should be conducted. A framework suggested by Keller and Jacka (1999) was found and partly used. The type of process map used was a cross-functional process map simply due to its ability to visualise the workflow. By utilising a process map the organisation got an overview of the different projects that have been implemented in their operations to face their rapid growth. As the aim was to create a wide, top down, map of the processes, the mapping itself was done from suppliers to distribution, including what the return flow processes looked like. The report and the mapping did not include the processes at suppliers but focused on how the inbound processes were handled and how load carriers were loaded to make necessary assumptions on the suppliers' processes.

2.5.2 ABC Classification and Lot Sizing

The ABC classification served to distinguish what products belonged to which category. In line with wishes from the focal company of identifying (and if possible reduce) tied up capital in inventories, the calculations were performed using volume value of the moving average purchasing price of the products and the number of articles from the same product that was shipped to customers. Articles registered in the system that had no moving average price nor a listed quantity were disregarded due to the assumption that these articles had not been active during 2016. The products receiving a high volume value were considered and classified as A-products. By using this calculation there was a combined consideration of both the price and capital tied up in the products as well as the amount of fast moving goods.

The classifications and requirements are listed below:

A - 70% of the volume value

B - 20% of the volume value

C - 10% of the volume value

Once the volume values were calculated, the products were sorted based on the size of their volume value. This led to the highest volume value on top with a falling volume value as the list proceeds. The selection of products to be further analysed were based on the main purchasing categories, Furnishings, Kids and Baby, Toys, and Clothes. The selection of products to be further analysed were based on their location in the volume value list where the highest volume value for each purchasing category and classification was selected. In order for a product to be selected and further analysed it had to have been active during the time span. To identify a product's activity and to acknowledge that the product had been active during the selected time period, at least one purchase of the product was deemed necessary. Above condition was mainly aimed towards products in the C classification as the formula used can visualise more expensive products higher up in the volume value list.

Due to the purchasing category Clothes' heavy dependency on trends and seasons, its purchasing activities were concentrated during some time-spans with low or non-existing activity for the rest of the year. Hence the products in the Clothes purchasing category were incomparable to products of the other purchasing categories with a more yearly spread on its activities and were hence disregarded in the analysis.

In order to visualise the different products characteristics, below table (Table 2) was expanded in the empirical chapter. As the price of the products were non-disclosable, the highest product's price was expressed as 100% as well as the same product's volume value, and the remaining products a percentage of the highest product price.

Table 2. Table illustrating the different characteristics of the selected products

Product Nr	Value	Volume (m^3)	Volume value	Average inventory

Once the products in every category and classification was identified a scenario could be built. The framework was provided by the theoretical study where the KPIs investigated were Capital tied up in inventories, Inventory holding costs and Inventory turnover rate. The reasoning for these KPIs were a combination both from what was expressed from the focal company and the purpose of the report where an impact on capital tied up in inventories were the result from a shift in average inventory. A simpler approach would have been to add a products volume as a parameter for the classification but this would skew the volume value classification and impact the classification on which products that actually belonged to which segment.

2.6 Reliability and validity

In previous chapters there has been a description on how the report was built and the following chapters motivate and discuss why and how these methods were chosen. As was argued earlier the report tackled both qualitative and quantitative data, which according to Bryman and Bell (2003) could be interpreted independently.

2.6.1 Reliability

According to Bryman and Bell (2003) the term reliability refers to two dimensions in qualitative studies, internal reliability and external reliability. Internal reliability refers to how the researchers/observers are in consensus regarding what they see and hear (Bryman & Bell, 2003). External reliability refers to which degree the report and studies performed can be replicated. Regarding the external reliability on the qualitative data collection used in the report there was an issues. The line of questioning were conducted in a semi-structured manner. Meaning that depending on how a replicating interviewer decides to formulate the questions to grasp an understanding of the point of interests, there could be different choice of words from the interviewee. However, it was believed that if the same point of interests was used, the outcomes would reach the same conclusion. In order to tackle the internal reliability, all semi-structured interviews were recorded to eliminate any misunderstandings or misinterpretations for the observers.

Reliability in quantitative studies refers to the consistency of the measures performed (Bryman & Bell, 2003). The quantitative data used in the report was therefore highly reliable as it was historical data (2016) and how it was interpreted is illustrated in chapter 4.

2.6.2 Validity

Validity and qualitative studies can according to Bryman and Bell (2003) be divided in two dimensions, internal validity and external validity. By internal validity Bryman and Bell (2003) refers to which degree the qualitative data gathered match the selected theory while the external validity refers to how the findings of a study can be generalised. The report's internal validity can be considered good as the theoretical study was based on the issues expressed and identified during the qualitative study. What further strengthens the internal validity was how the quantitative data argued for some of the identified issues. As the report was considered a case study, the results were harder to generalise to external organisations as the results were highly dependent on a similar context.

Quantitative validity refers to if a measurement of a concept really is a measurement of the concept (Bryman & Bell, 2003). As the results from the report were based on the focal company data and the conducted results were compared to the focal company's historic figures, the measures show good validity. However, as the report utilises a sample of the gathered data the validity was immediately reduced. This was counteracted by a classification of the data, which helps to a point. The sampled and classified data showed good validity while the generalisation of these did not. Meaning that the results from the report were not entirely measuring the concept.

3. THEORETICAL FRAMEWORK

In order to get an insight to the current logistical processes of Jollyroom and identify certain problem areas within the physical flow, an initial part of the theoretical framework consists of theory concerning process mapping. The subsequent section focuses more on organisational theory connected to the work performed by the purchasing department. Often, this is a part of the organisation that makes critical and sometimes decisive decisions that can have a major impact on inventory levels. Lastly, the theoretical framework brings up theory about inventory management and how various parts within this field can affect and contribute to the lack of space that Jollyroom currently experiences. Hence, areas such as ABC-classification, economic order quantity, service levels and safety buffers are described since they are all essential concepts when discussing warehouse efficiency.

3.1 Process mapping

There are often several reasons to perform process mapping, although in most cases it is about making the work visible. Damelio, 2011 states that process mapping often contributes to increased knowledge and understanding, which can then be used to achieve a specific goal that usually aims to measurably improve the business. Keller and Jacka (1999) suggest five different steps, namely: establish process boundaries, develop the data gathering plan, interview the process participants, generate the process maps, and analyse and use the map. These steps could be followed when mapping a process for improvement purposes.

3.1.1 Cross-Functional process map

A Cross-Functional Process Map (CFPM), sometimes also called Swimlane diagram, aims to visualise the workflow in organisations (Damelio, 2011). As the name suggest, the work often crosses several different functions which the horizontal fields of the diagram are supposed to illustrate. Damelio, 2011 mentions several reasons why to use this kind of map. Some important characteristics is that it shows the boundaries of a workflow and can clarify in what stages customer contact is being made. Moreover, the map describes if parts of the workflow is conducted in serial, collaborative, parallel or in a combination. Another important aspect is that boundaries, in terms of organisational responsibilities, easily can be illustrated.

3.2 Key responsibilities of a purchasing department

The purchasing function’s main responsibility is to ensure that goods and services that are needed within a company are secured at the most favourable conditions (van Weele, 2015). The importance of the purchasing department is clearly emphasised also by Crandall, Crandall and Chen (2012), who considers the function as a key participant of supply chain inventory management. Looking closer at the purchasing process model presented by van Weele (2015), the work is divided into different activities even though they are all closely interrelated. The tactical part of the purchasing process involves determining the specification, selecting the supplier and establishing an agreement in terms of a contract. These are tasks that are performed when a need of new goods or services are required or if it has been decided to replace a current supplier with a new one. The ordering function is the other part that makes up the purchasing process model. Here, it is instead a focus on ordering, expediting and making evaluations of the suppliers. Van Weele (2015), further describes that many different terms are used to describe purchasing and that this sometimes creates some confusion and misunderstanding. Hence, some responsibilities that are important to distinguish and should not be associated with a purchasing function are materials planning, materials scheduling, inventory management, incoming inspection and quality control (van Weele, 2015).

3.3 Inventory management

Inventory management is a collective term that includes the planning and control of inventory, which in turn aims to maintain a desired level of stock for specific products and items (Toomey, 2003). What is considered to be a desired level can be questioned, but usually it means that a company holds enough inventory to satisfy customer demand without holding too much. Intuitively, keeping just the right amount of stock will minimise the costs, however this is often easier said than done, especially when it comes to balancing demand with supply for thousands of stock-keeping units (SKUs).

3.3.1 Inventory turnover rate

The inventory turnover rate is defined as the ratio between the cost of goods sold and the average inventory level. It is one of the most commonly used metrics for evaluating and comparing the inventory performance of small, medium and large size companies (Hançerlioğulları, 2015). Equation 1, below shows how the inventory turnover rate is calculated for a single product. However, if the aim instead is to consider a group of articles or the full range of articles, equation 2 should be preferred.

$$Inventory\ turnover\ rate = \frac{Annual\ number\ of\ consumed\ units}{Average\ inventory} \quad (1)$$

$$Inventory\ turnover\ rate = \frac{Cost\ of\ goods\ sold}{Average\ inventory} \quad (2)$$

The inventory turnover rate is an important measure as it also provides an indication of a company's liquidity. Accordingly, a high ratio means that the inventory turns several times during a year which is a sign of a good inventory performance, while a low ratio often means overstocking, risk of obsolescence and high inventory holding costs (Damron, Rupp & Smith, 2016). On the other hand, (Damron, Rupp & Smith, 2016) mentions that there may also be some problems with relying too much on the ratio since a very high value instead can be an indication of losses in sales due to inventory shortages. Furthermore, the importance of comparing the ratio to other businesses in the same specific industry is emphasised since companies working with for instance perishable inventory for natural reasons have a higher turnover compared to companies selling vehicles.

3.3.2 Service levels

Service level describes the probability that a stocked item can be delivered and represents a measure of supply readiness (Mattsson, 2008). There are two different methods that are frequently used within industry, however there are some different opinions about the conditions under which each method should be used. The first method is known as cycle service and is defined as the probability of not getting shortages during an inventory cycle. According to Mattsson (2008), it is the most commonly used method within industry, thus there is a great deal of experience and understanding regarding its use. Fill rate, which is the other method, is defined as the share of demand that can be delivered directly from stock. This approach has the advantage of being similar to order line service, thus opening up the possibility of comparing the designed level of safety stock towards the level of service that is actually reached (Mattsson, 2008). The two different methods are shown in equation 3 and equation 4 (Jonsson & Mattsson, 2009).

$$Cycle\ service = 1 - \frac{No.\ of\ inventory\ cycles\ with\ shortage}{Total\ no.\ of\ inventory\ cycles} \quad (3)$$

$$Fill\ rate = \frac{Part\ of\ demand\ that\ can\ be\ delivered\ directly\ from\ stock}{Total\ demand} \quad (4)$$

3.3.3 Safety buffers

Two of the main reasons for keeping inventory are economies of scale and uncertainties (Axsäter, 2006). To exemplify this, a purchasing department often strives to order batches in large quantities in order to get volume discounts. Similarly, a producing company tries to achieve long production runs to avoid spending a lot of time and resources on the setup of production equipment. Considering uncertainties, they are always present when discussing supply and demand. Shortages of supply could for example occur due to suppliers' lack of ability to deliver what is needed. In addition, it is also possible that transport problems arise somewhere along the way. It is often difficult to anticipate problems of such a nature, thus the need for some extra assurance in terms of a safety buffer arises.

Calculation of safety buffers

There are several ways of making an assessment of the size of the safety buffer. However, usually it is based on a statistical analysis focusing on the spread in demand. Combining the calculated standard deviation with a safety factor, which is accessed after deciding a desired service level, the size of the safety buffer can be obtained. To estimate the standard deviation Jonsson & Mattsson (2013) describes that it is possible to neglect the uncertainty in lead time. It is then assumed that the lead time variation can be considered as small or that the lead time is relatively short. Equation 5 below, shows how the standard deviation of demand during lead time can be calculated.

$$\sigma_{DDLT} = \sigma_D \times \sqrt{LT} \quad (5)$$

$\sigma_{DDLT} =$ *Standard deviation during lead-time*
$\sigma_D =$ *Standard deviation of demand during the time period*
$LT =$ *Average lead-time in time units from order to delivery*

According to Jonsson & Mattson (2013) the most accurate procedure is to conduct the dimensioning of the safety buffers based on desired service levels and the articles demand variation. If the service level is defined as a percentage that corresponds to the likelihood of not getting shortages during a replenishment cycle it is possible to use a normal distribution table (see Appendix A), to directly extract a safety factor. Then it is possible to complete the safety buffer calculation based on equation 6.

$$SS = k \times \sigma_{DDLT} \quad (6)$$

If instead following the steps of calculating the fill rate, the service loss function must first be calculated based on equation 7. When the value of the service loss function is received, it is possible to read the safety factor from a service loss table. The safety factor or z-value can then be used directly in equation 8 to receive the safety stock.

$$E(z) = \frac{(1 - Fill\ rate\ level) \times Q}{\sigma_{DDLT}} \quad (7)$$

$$SS = \sigma_{DDLT} \times z \quad (8)$$

3.3.4 Inventory management through differentiation

A common way of differentiating articles and rationalising the management of inventories is to use an ABC-classification (Teunter, Babai & Syntetos, 2009). It is a method that can be used to provide an overview of where to spend company resources in order to get as much as possible in return in terms of resource input (Jonsson & Mattsson, 2013). The original ABC rating considers the volume value of the articles and is based on the 80/20-rule, which means that about 20% of the articles account for about 80% of the volume value. Consequently, the remaining 80% of the articles account for only about 20% of the total volume value.

When making the split into the different classes, one common way to make the classification is to set class A to represent 10% of the total number of articles, class B to equal 30%, and class C to represent 60% of the total range of articles (Axsäter, 2006). Jessop and Morrison (1994) instead suggest to set the limits between the categories based on the volume value of the products. Volume value can also be expressed as demand value and is the most traditional classification approach according to Teunter, Babai and Syntetos (2009). It is then suggested to let the A-articles represent 70% of the volume value, B-articles to correspond to 70-90% of the cumulated volume value, and C-articles to equal the remaining part of the volume value (Jessop & Morrison, 1994).

3.3.5 Lot sizing methods/optimal order quantity

Achieving the right inventory levels can be a difficult task. Several different factors are involved and needs to be considered in order to find an appropriate level of stock. When deciding to use a lot sizing method it is the quantity and frequency that are of importance. Both factors can be limited due to different reasons. As an example the quantity preferred by a company may not be possible to order due to supplier limitations. Also the frequency of placing orders might be restricted due to limited periods of time when order placement is possible or even allowed by the suppliers. Seasonal products such as clothes can be assumed to fit into a category where problems of this character might arise. To distinguish between different lot sizing methods, they can be divided into semi-dynamic and dynamic groups which is described more in detail below.

Semi dynamic models

Lot sizing methods that are divided into semi dynamic models are either variable in terms of order frequency or order quantity. The objective when applying the models is to take a total cost perspective and find the most economic viable quantity or frequency when placing the order.

Economic order quantity

The economic order quantity (EOQ), also known as the Wilson formula, is a well-established and commonly used method for calculating a fixed order quantity or lot size (Jonsson & Mattsson, 2009). The formula is designed to consider both the ordering cost and the inventory holding cost and seeks to identify the minimum total cost that is associated with an order. Equation 9, shown below, illustrates how EOQ is calculated.

$$EOQ = \sqrt{\frac{2 \times D \times S}{I \times C}} \quad (9)$$

$D = Demand\ per\ time\ unit$

$S = Ordering\ cost\ per\ ordering\ occasion$

$I = Inventory\ carrying\ cost\ per\ time\ unit$

$C = Item\ value\ per\ stock\ unit$

Each order and delivery is associated with an ordering cost that includes all those costs involved for carrying out the order process and procure articles or material from an external supplier. These costs are generally not affected by the order size, thus making it more beneficial to increase the size of the order and hence reducing or splitting the costs on a larger number of units.

In most cases the order quantity is greater than the immediate demand which creates a need of keeping the excess in stock until it will be consumed or shipped. Inventory carrying costs then arises which are generally assumed to be proportional to the value of the stock and increase as the number of articles in stock increases.

Since the inventory carrying cost increases and the ordering cost per unit decreases, when increasing the order quantity, there is clearly a trade-off between the two cost elements. The desired minimum cost and hence the EOQ is illustrated in figure 2 below.

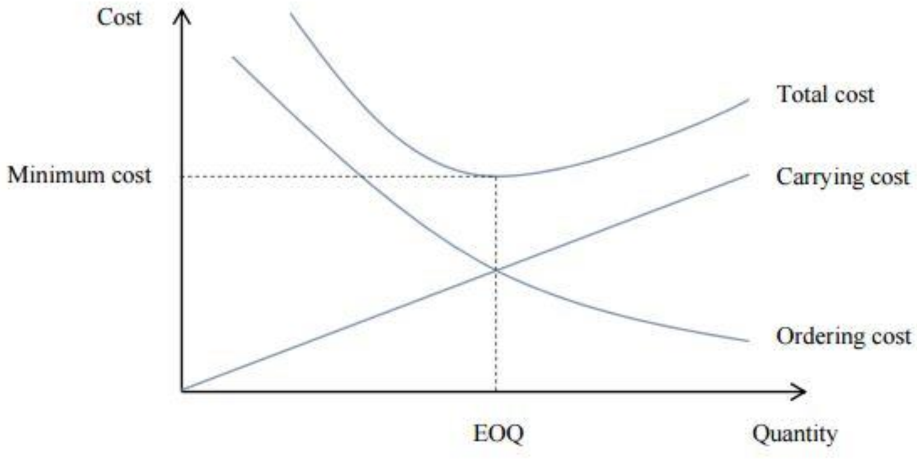

Figure 2. Illustrating the economic order quantity

At first glance the formula and figure may appear quite simple, however both the ordering cost and inventory carrying cost consist of various unique elements such as internal and external transports, cost of rent, cost for insurance and costs for employees, only to name a few. Furthermore, the formula is based on the following assumptions which are important to be aware of before applying the calculations (Jonsson & Mattsson, 2009).

1. Demand per time unit is constant and known
2. Lead time for stock replenishment is constant and known
3. The entire order quantity is delivered at once
4. Ordering costs per order occasion are constant and known, and are independent of order quantity
5. Inventory carrying cost per piece and time unit are constant and known, and are independent of order quantity
6. Purchasing price is constant and known, and independent of order quantity and purchase occasion.

Economic run-out time

The economic run-out time (ERT) is a method that is meant to cover the time during which a delivered quantity can be expected to last based on current demand. If making a comparison with EOQ, the model is instead variable in terms of quantity and fixed when it comes to order frequency. However, even though the characteristics of these parameters are the direct opposite, economic run-out time still has a close connection to the previous method since EOQ first must be calculated and then divided with the average demand per time unit, which is shown in equation 10 below.

$$ERT = \frac{Economic\ order\ quantity}{Average\ demand\ per\ time\ unit} \quad (10)$$

Dynamic models

The dynamic models are variable both in quantity and frequency. More specifically, it means that the order quantity is recalculated for each new order created and thus varies during the planning horizon. The methods are generally more complex to use but offers often a more reliable and cost-optimal order quantity that considers changes in ordering costs and inventory carrying costs. On the other hand, there is also some problems with these dynamic fluctuations which can create extensive rescheduling and rough changes in material flows (Mattsson, 2009). The models are therefore in first hand suitable for environments where the demand is relatively balanced.

3.3.6 Estimating lot sizing parameters

When making lot size calculations there are especially two parameters, the ordering cost and inventory carrying cost that needs to be described more in detail. As previously mentioned they consist of several elements that can be difficult to estimate.

Ordering cost

The ordering costs are associated with the handling of purchase and manufacturing orders. According to Jonsson and Mattsson (2011), it is the incremental costs that are of importance when trying to find the most cost-optimal lot size. This is mainly due to that the incremental costs are a part of the total ordering cost that varies when the number of ordering occasions changes during a defined period of time. The incremental order costs can arise due to several different activities that are associated with a procurement process. A list of 15 different activities, compiled by Mattsson (2017) can be found in Appendix B and shows how these activities mainly are linked to costs of transportation, handling, personnel and data processing.

Inventory carrying cost

The inventory carrying cost arises as a result of keeping articles in storage. It should be determined on a rather short-term basis since several of the cost elements involved are either semi-fixed or variable costs that often changes from one year to another, see Appendix C compiled by Mattsson (2017). The inventory carrying cost consist of four main cost components which are capital cost, cost of space, risk cost and warehousing service cost (Lambert & Stock, 2001).

3.3.7 Justification of selected alternatives

Safety stock it is often decided based upon the desired service level. Since safety stock calculations is not a part of the inventory management at Jollyroom they are not using any kind of service level measurement. Instead, a fulfillment rate is being used that serves to measure whether the company is able to deliver the product or products that constitute a received customer order. Thus, a damaged product or incorrect value of inventory are two likely causes that pulls down the fulfillment rate. So, there is no actual measurement that evaluates and considers if the product is unavailable to the customer when placing orders online, which means that there is an unawareness of the extent to which sales are lost. Therefore, cycle service is considered to be the more relevant service level model for Jollyroom since it deals with the number of inventory cycles with shortages rather than the part of demand that can be delivered directly from stock.

Considering choosing method for finding suitable lot sizes it is suggested that a semi-dynamic model should be used. This is mainly due to the reasoning by Mattsson, 2009 who mentions that the dynamic models are more complex. In the case of Jollyroom it is viewed to be unfavourable to begin a more structured approach by following a method that is considered to be fairly difficult and would require a large effort of work. With a focus more on the semi-dynamic models the EOQ-model is the one that will be used in the following parts of the study. Jonsson and Mattsson, 2009 describes the model as a well-established and commonly used method for calculating a fixed order quantity. Since the alternative ERT-model is largely based on the EOQ-calculations it would be rather simple to consider the average demand per time unit at a later stage if desired.

4. EMPIRICAL FINDINGS

In the following chapter, a description and compilation of the empirical data will be addressed. The chapter begins with a company description followed by descriptions of the different departments and the process maps.

4.1 Context description

Jollyroom is an e-commerce actor active in the segment with selling goods for babies and kids ranging from the ages of 0-12, as well as a full assortment for pregnant women. The organisation can be divided in four main departments, namely: Purchasing and Marketing, Warehouse operations, Financial, and Human resources. The sources for the empirical data are from the purchasing department and warehouse operations. The company utilises the ERP-system SAP, which is utilised in all departments where some departments utilise different customised segments of the system.

Jollyroom has a shipping partner that mainly handles the inbound freight from Asian suppliers as well as some European shipments who is able to provide buyers council of products on several locations in Asia. Buyers council refers to the ability to coordinate and fill containers from different suppliers on location.[3]

4.2 The purchasing department

The purchasing department is divided into four categories, namely: Kids and baby, Furnishings, Clothes, and Toys. The different categories are responsible for the purchases of products that fits their category's product mix. The characteristics of products for Kids and baby are for instance baby strollers, car seats, safety products and products linked to transportation of kids and babies while the characteristics for furnishings are ranging from beds and cribs to lamps.[4]

[3] Key account manager (Shipping partner). Interviewed by the authors 2017-04-20
[4] Purchasing manager (Jollyroom). Interviewed by the authors 2017-02-07

The organisation of the categories consists of one category manager and a number of purchasers and purchasing assistants depending on the number of SKU's and suppliers used for the category.[5]

The role of the purchasing department is two-sided, they are responsible for all incoming products as well as the sales and campaigns of the same products that is tied to the different categories[5]. The purchasers and category managers are hence evaluated on their ability to sell the purchased products with a good profit margin and avoid slow-moving goods[6].

As the suppliers in Europe and Asia are spread on large geographical areas, the delivery lead times are estimated to 5 days for European suppliers and 90 days for Asian suppliers.[6]

In regards to limitations set on the purchasing department they are relatively few, where as long as they are purchasing products within their range, with good margins, and a wide assortment they only need to account for the category's warehousing budget, expressed in SEK.[7]

4.2.1 The purchasing process

In the process map describing the purchasing process (Appendix D) the process begins with the 'Identification of product need', which means that any of the categories realise or identify that a certain product would prove valuable to the assortment with a good profit margin structure[8].

After identifying the product need a distinction is made whether the product need is for an existing product that is already part of the assortment or if it is a new product where the process differentiates.[8, 9]

If it is a new product the process is further differentiated depending on if it is a product to be produced by an European brand or import the product from Asia. Once the decision to continue with the product, both regarding a new product with an European

[5] Category purchasing manager 1 (Jollyroom). Interviewed by the authors 2017-02-17
[6] Category purchasing manager 2-4 (Jollyroom). Interviewed by the authors 2017-02-17
[7] Category purchasing manager 1-4 (Jollyroom). Interviewed by the authors 2017-02-17
[8] Category purchasing manager 2 (Jollyroom). Interviewed by the authors 2017-03-09
[9] Category purchasing manager 3 (Jollyroom). Interviewed by the authors 2017-03-08

brand as well as Asian imported brand, Jollyroom requires the supplier to fill out an "import sheet", a sheet with information about the supplier and product, which is later imported into Jollyroom's ERP system (SAP).[8,9,10]

If the identified product need is for an existing product the purchasing category evaluates the sales rate manually. There is a possibility in the system to view how the product sales has been recently, which is then compared to the available stock. This manual process is usually performed once a week (more often for fast moving goods) per supplier and product[8,9,10]. The process can be performed automatically by SAP but is currently not utilised[9].

After the existing products sales rate has been analysed, a decision regarding lot size is conducted. Depending on the product, the season and its sales rate, European brands are ordered in different lot sizes used to cover for varying time-spans and often in quantities to meet the demand to utilise free shipping (FCA). When selecting the lot size for products with the Asia imported products, they are made with the aim to fill one TEU.[8, 9, 10]

The purchasing category then updates and creates a purchase order (PO) in the system which generates a PO-document that is sent to the supplier. As the purchasing categories are independently of each other placing POs to suppliers there are different requirements put on suppliers. Some categories for instance require a order confirmation on a placed order within 24 hours. The order confirmations should include a purchase invoice along with adjustments to the order which needs to be accepted by the categories. It is common for the order confirmations to return with an adjusted quantity which requires the purchasing category to update the system with the new inbound quantity.[9,10]

The Asian suppliers are instructed to contact Jollyroom's shipping partner to book transportation. Once Jollyroom receives the B/L the PO in the system can be updated with a new ETA.

The delivery of European brands products are usually performed via free shipping, and the cost of transportation is included in the products price.

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[8] Category purchasing manager 2 (Jollyroom). Interviewed by the authors 2017-03-09
[9] Category purchasing manager 3 (Jollyroom). Interviewed by the authors 2017-03-08
[10] Category purchasing manager 4 (Jollyroom). Interviewed by the authors 2017-03-09

4.3 Warehouse operations

The warehouse operations can be divided into three main categories, namely: inbound deliveries, Outbound deliveries, and Claims and returns. Currently, Jollyroom operates in three different warehouses, which are containing and handling different characteristics of products. Warehouse A handles small goods, smaller than one meter in any dimension, warehouse B handles large goods and warehouse C is utilised as a buffer for both warehouses, see figure 3 for a geographical reference of their locations. Inbound deliveries operate in all three warehouses while outbound deliveries operate in A and B and Claims and returns are only located in warehouse B. All three warehouses are receiving goods, where small goods are delivered directly to warehouse A, large goods directly to warehouse B and goods transported by boat is received at either of the warehouses but primarily at C.[11]

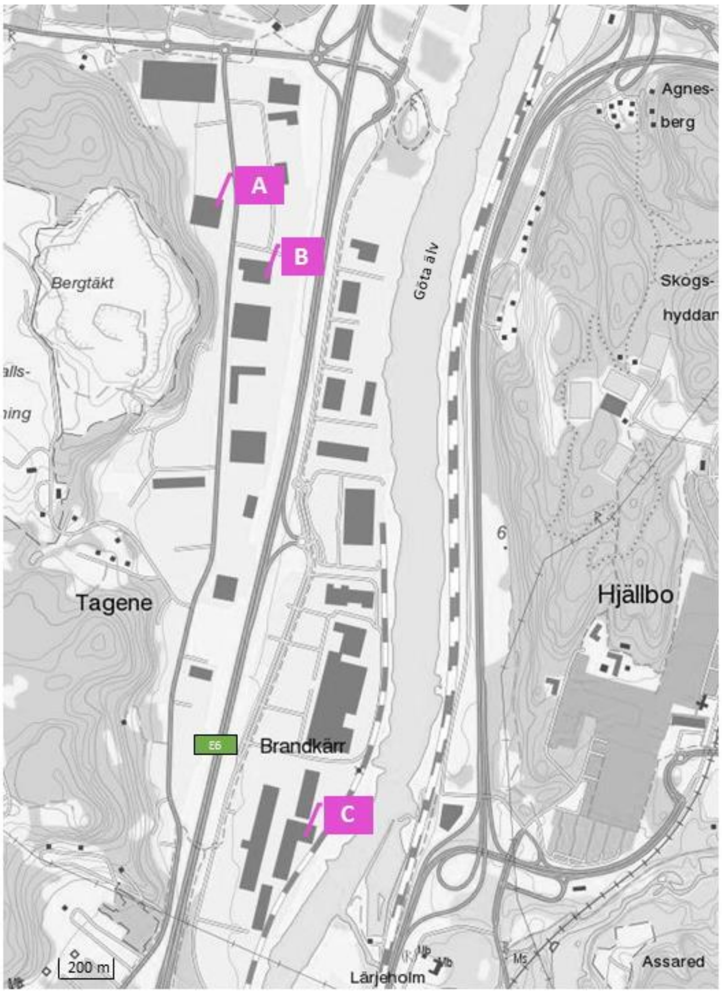


Figure 3. Illustration of Jollyroom's three warehouses

[11] Warehouse manager (Jollyroom). Interviewed by the authors 2017-02-01

The organisation is divided based on the above categories. As there are inbound deliveries at all three warehouses, there are staff from inbound deliveries at each of the three warehouses. There are outbound deliveries performed at both warehouse A and B, hence staff from outbound deliveries are present in both locations.[11]

4.3.1 Inbound deliveries

Due to low coordination of inbound deliveries there are varying quantities received on a daily basis, resulting in a difficult planning environment, inbound goods can be kept in a two days buffer in order to better plan the man-hours required for the following day. In the current setting only 30% of the suppliers are notifying a delivery[12]. In Appendix E the inbound deliveries start with goods arriving to Jollyroom. While unloading the goods, the goods is inspected for external damages linked to the transportation. If there are damages these are discussed with the driver and later forwarded to the correct instance of Jollyroom for the appropriate proceedings. Once the goods is unloaded it is transported to a buffer area while the goods is manually registered as arrived. In this step the supplied packing list is compared towards the PO to identify if there are any discrepancies. If there are discrepancies the inbound delivery staff can adjust the PO in accordance to the packing list but if the discrepancy is on a large quantity they forward the errand to the purchasing department. Once the packing list and PO has been compared and approved, the inbound delivery can be initiated in the system. Each pallet of arrived goods receives a physical goods flow document and is transported to the inspection area. If it is a new product, not yet in the system, the system requires weight and volume measurements. This data should be provided and filled out by the suppliers when filling out the import sheet sent out by purchasing, but it is often faulty or incomplete.[13]

Once the goods have its measurements in system, the content and quantity of the delivery is manually inspected against the PO and the waybill. If the quantities do not match an error for discrepancies is conducted. Once conducted or if the quantities matched, the inbound delivery process is closed and receives a transport order (TO). The goods are transported to a temporary loading zone for the warehouse awaiting to

[11] Warehouse manager (Jollyroom). Interviewed by the authors 2017-02-01
[12] Inbound deliveries controller (Jollyroom). Interviewed by the authors 2017-03-16
[13] Inbound deliveries team leader (Jollyroom). Interviewed by the authors 2017-03-27

be placed at its assigned location. The TO destination location is assigned by the system based on the weight and volume of the goods. The system has been provided with data regarding volume for all storage locations in the warehouses and is therefore able to dictate where a shipment should go. Meaning that there is no location designated for a certain product.[13]

4.3.2 Outbound deliveries

The outbound deliveries process begins with a customer order. The customer orders are sorted and compiled by the system until the compiled order picklist is printed, see Appendix F. Since the volume of each product should be in the system, it can optimise which cart to use for the most amount of orders that fit on a specific cart. The system prints a compiled picklist under one TO every hour. A picker receives a TO, identify which cart to use, and attach the assigned cart to an Ergomover, scan the barcode of the printed TO by which they receive the first picking location. The picker transports the cart to the given location and the products EAN code is scanned. When the right products EAN code is scanned and there are more products yet to be picked to the cart, a new picking location is given. Given that there are no dedicated locations for products in the warehouses an expressed issue is that two of the same product could be physically close to one and another, and if the given location is empty and awaits a refill, the picker is able to pick the right product from the wrong location. This is expressed as an issue as the system does not recognise that the product is picked from another location than what it had stated, which could cause stock balance issues at a later stage.[14]

Once the picker has scanned all products registered to the TO, the cart is transported to the packing area. The packing operations are divided in two sections based on the order's destination country, EU- or non-EU member state.[14]

The packer in the EU-section scans the TO's EAN code and enters a section number of the cart (equivalent to one customer order) and receives the packlist for the entered section number. The articles listed on the packlist are scanned and ticked off the packlist. If there are more than one article tied to one customer order, these products

[13] Inbound deliveries team leader (Jollyroom). Interviewed by the authors 2017-03-27
[14] Outbound deliveries team leader (Jollyroom). Interviewed by the authors 2017-03-24

are consolidated into one carton. Once all products has been ticked off the packlist, a waybill can be printed. Some products require bubble wrapping to reduce the risk of transportation damage and are hence moved to a bubble wrap station with the printed waybill. Once an order is packed and the waybill is attached, the order is transported to the loading area.[14]

The packer at the non-EU section has a similar process but with one time constraint. As the products to be shipped to non-EU countries require customs documentation. Goods for non-EU countries has one dedicated departure (available to book more if necessary), and the customs documents needs to be finalised before this departure. This means that once this process is under way, all packing activities for non-EU countries are stopped. Once the process is complete the packing can continue as before, but once they are executed the orders are to be held until the following shipping occasion. Once at the loading area, the orders are palletised or placed in cargo cages (only EU countries) and loaded onto a trailer.[14]

4.3.3 Claims and returns

The claims and returns department at Jollyroom handles the return flow of goods. In order for a customer to make a return or claim on a product, the customer needs to contact the customer support who analyse and discuss the issue and later gives the customer a waybill for the transportation to Jollyroom and updates the system with the errand. This process, to go via the customer support, is in place to reduce the transportation and to ship back a product that is broken/faulty to Jollyroom when it could be cheaper to simply send a new product and let the customer get rid of the faulty product themselves. The claims and returns process begins with customer support, while the physical and mapped flow illustrated in Appendix G, starts with the goods arriving. The goods are unloaded by the staff at claims and returns, the packages of the shipment are inspected and scanned to identify if the package/goods are a claim or return. If the package is from a claim errand, it is moved to claim section. The staff at the claim section inspect the goods to identify if the product is in a repairable state. If the product is repairable it is moved to a workshop where the supplier of the product is contacted. Jollyroom are usually in possession of spare parts,

[14] Outbound deliveries team leader (Jollyroom). Interviewed by the authors 2017-03-24

or are regularly ordered. Once the spare parts needed are collected, the product is repaired and shipped back to the customer. To note is that Jollyroom has three attempts to repair a product before they are required to ship a new product. If the product is not in a repairable state the staff at the claims section are compiling claim documents for suppliers and forward these to purchasing while the customer is refunded or receives a new product and the broken/faulty product is scrapped or sent to the supplier.[15]

The products that are part of the return flow is less complex. The package is moved to the returns section where the customer gets a refund for the product. The product is inspected to identify its state, if the product is still in good shape it can be taken back to the warehouse to be bought from another customer and if it is in a bad shape (broke carton etc.) it is taken to the warehouse store or simply scrapped. The warehouse store is a dedicated area where these products are shelved. It is a physical store meaning that customers can walk in and purchase products at a discounted price.[15]

4.4 Result of ABC-classification and lot sizing calculations

The following chapter discloses how the ABC-classification were performed along with illustrations of selected products inventory during 2016. The initial part of the chapter describes how the classification was performed and later, the illustration for each selected product is described and presented.

4.4.1 Classifications

Currently, Jollyroom offers an assortment with over 45 000 different articles. The wide range of products is a deliberate strategy which is not unique for the company but goes in line with many other e-commerce actors. When it comes to managing the inventory of all products, there is reason to have different approaches considering that the characteristics of the products differ. The most commonly used method for differentiating products is to classify the products based on what is known as an ABC-classification. In this study, volume value has been used as a parameter to distribute the products into the three different categories. The reason for this is mainly due to the

[15] Claims and returns manager (Jollyroom). Interviewed by the authors 2017-02-08

findings from the theoretical study but also since it puts weight into sales and purchase price of the product, factors that are important to Jollyroom. The limits for the classification follows what is suggested by Teunter, Babai and Syntetos (2009). Thus, A-products will be those that make up 70% of the volume value, B-products 20% of the volume value and C-products the remaining 10% of the total volume value as can be seen in figure 4.

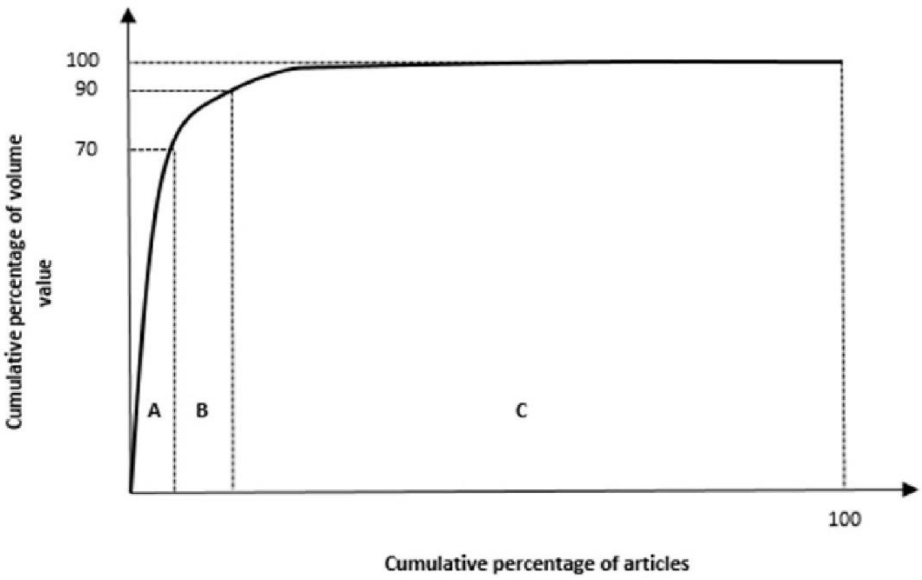


Figure 4. Illustration of the differentiation based on volume value

A sample of 18 different products have been chosen for evaluating the effect of following a structured and more theoretical approach compared to what is currently used. It has been taken into account that Jollyroom is divided into four different purchasing categories, however clothes have not been a part of the selection due to deviating purchase conditions such as clothing collections that are exclusive for only one season. Furthermore, the conditions and terms for buying products from Europe and Asia differs as well. Hence, it has been considered important to take this into account and assure that one product from each A-, B- and C-category is examined for each geographical area (Figure 5).

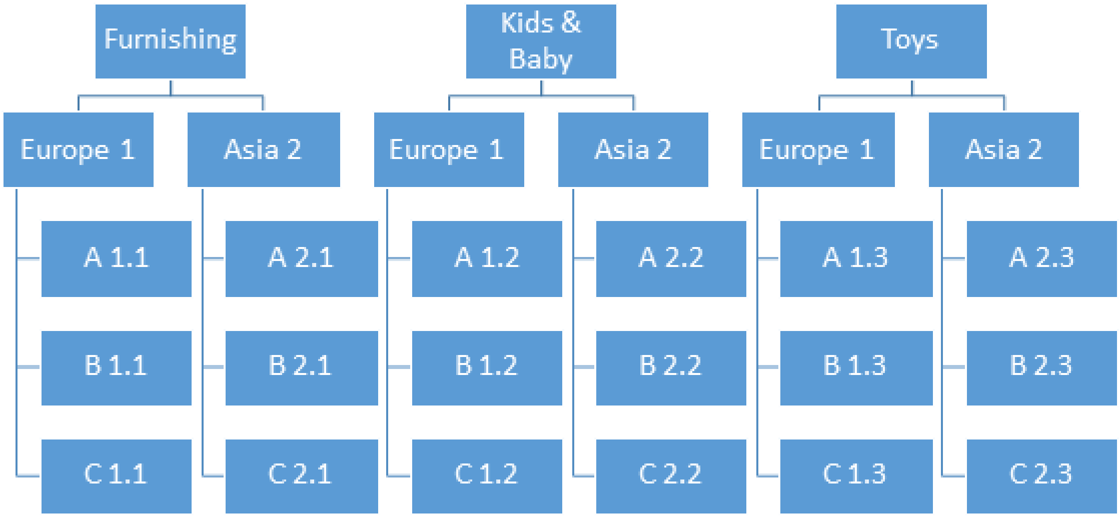


Figure 5. Illustrating the differentiation based on origin.

The table below (table 3) shows the different classified products volume in m^3/article, the calculated volume value of the article, and the average inventory carried of the product during 2016. The average volume for the products in below classification are for A 0,1239 m^3, B 0,028 m^3, and C 0,0035 m^3. As the value of the products are non-disclosable, the volume value and value of the article have been replaced with a percentage based on the most expensive product, A 2.2, which has a value of 100% (Table 3), and the same article's volume value is used as a reference point towards the other articles.

Table 3. The table lists the selected products characteristics

Product nr.	Value (%)	Volume (m^3)	Volume Value (%)	Average inventory (pcs)
A 1.1	32,35%	0,035152	129,70%	227
A 1.2	41,17%	0,12672	243,90%	309
A 1.3	5,74%	0,003	63,77%	987
A 2.1	29,88%	0,128464	44,94%	229
A 2.2	100%	0,1833	100%	84
A 2.3	22,24%	0,26676	77,67%	191
B 1.1	43,23%	0,0864	2,31%	9
B 1.2	68,77%	0,0693	2,31%	5
B 1.3	2,51%	0,001732608	2,31%	42
B 2.1	1%	0,000576	2,28%	933

B 2.2	3,04%	0,00594	2,26%	284
B 2.3	2,73%	0,00396	2,30%	145
C 1.1	3,24%	0,005724	0,33%	6
C 1.2	1,83%	0,0007695	0,33%	20
C 1.3	6,26%	0,0018	0,33%	9
C 2.1	0,2%	0,005445	0,32%	210
C 2.2	1,28%	0,001575	0,29%	138
C 2.3	0,88%	0,005887	0,33%	205

4.4.2 Inventory levels during 2016

In the following section three of the above listed (Table 3) product's inventory cycles are presented. The selected products to be presented are A 1.2, B 1.1, and C 2.1 as they illustrate the different ranges of the metrics presented.

Before the illustrations are presented, there is a need to explain how the scenarios were performed. In the 'current state' (2016) for the classified products, the level of inventories was based on what was left at the end of 2016 according to the data from SAP. With this, the different movement types of a product were sorted in a chronological order with adjustments to the ingoing inventories to be able to meet the outgoing inventory balance. The inventory was then calculated based on the different movement types and it is these points that are visualised. *Note that the Y-axis of the different illustrations are presented with varying scale.*

4.4.3 A-products Europe & Asia

The selected product to visualise A-products is A 1.2, which is relatively expensive and big in volume (m^3). As can be seen in below figure (Figure 6) the ordered lot size range from about 100-400 pcs and during different times of the year. The inventory build-up in the latter part of the year are due to the sales heavy and campaigns run during this time of year, such as black Friday- and Christmas campaigns. In this product's specific case, approximately 25% of the yearly sales were performed during the last two months. As is mentioned in Table 3, the average inventory was 309 pcs, despite the low inventory held during mid-January to mid-April, and an inventory turnover of 9,74.

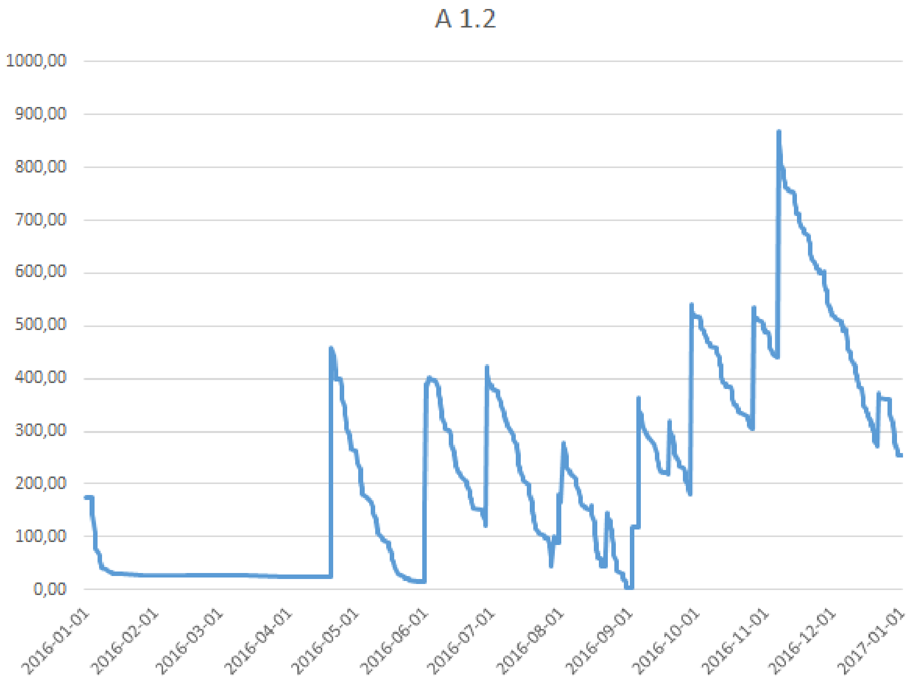


Figure 6. Illustrating the inventory levels of product A 1.2 during 2016

4.4.4 B-Products Europe & Asia

The selected product to visualise the B-products is B 1.1. Which in size and price is relatively similar to the A-product selected. However, as is visualised in figure 7 below, the illustration for product B 1.1 shows inventory levels in much lower numbers. For this product, the lot sizes range from 2-7 pcs per order occasion. As the illustration shows, the price for product is relatively high, considering it is in the B-classification with such few outgoing movement types. One third of the product's yearly sales are performed during the last two months.

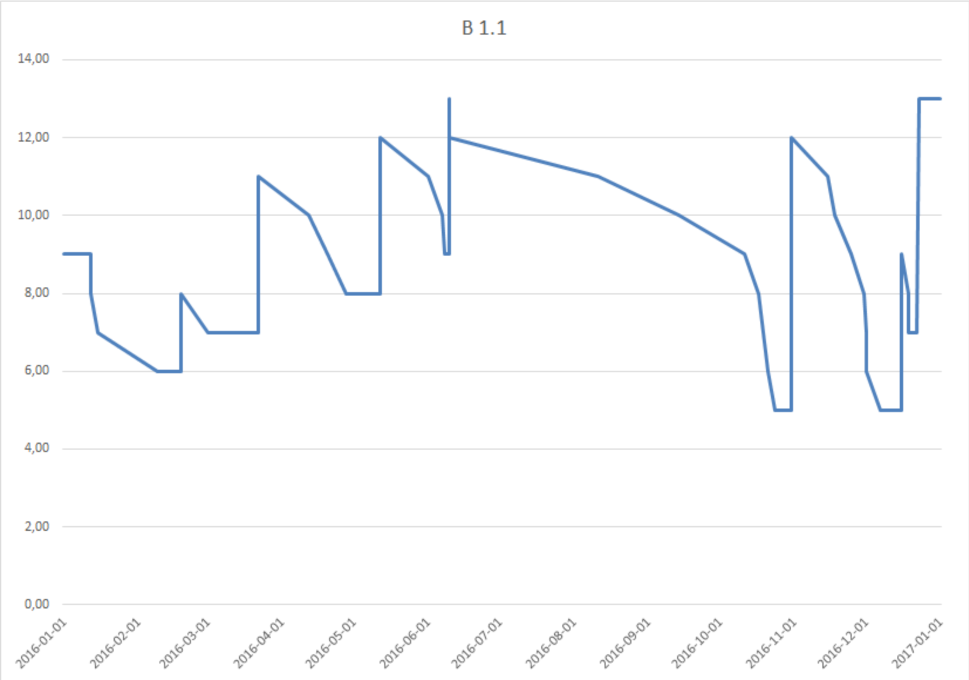


Figure 7. Illustrating the inventory levels of product B 1.1 during 2016

4.4.5 C-Products Europe & Asia

In contrast to the previous two examples (Figure 6 and 7) the article chosen to illustrate the C-products below (Figure 8) is relatively cheap, but with more outgoing movements. As there were few purchases made of this product during 2016, not a lot can be said about the lot sizes, other than the big lot size that arrived in the end of April. As the product is imported from China the larger of the two quantities isn't as unexpected as the smaller one. What separates this article from some of the others is the lack of inventories held during the last two months. As is shown in Table 3, the average inventory held during 2016 of this article was 210 with an inventory turnover of 3,96.

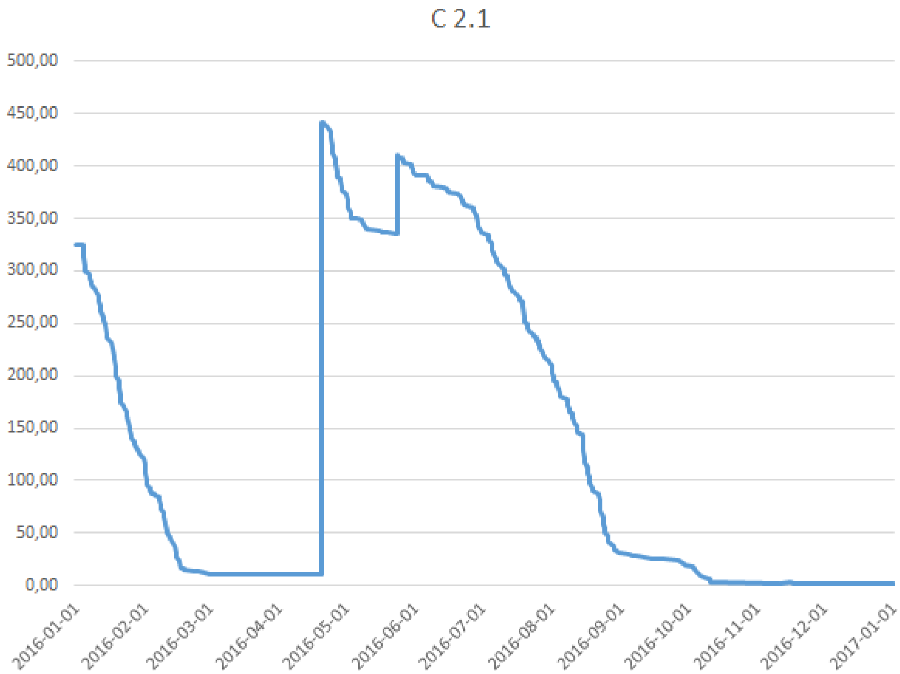


Figure 8. Illustrating the inventory levels of product C 2.1 during 2016

5. ANALYSIS

In the following chapter a presentation of the achieved result is accounted for. The result handles an analysis of the qualitative data based on the report's purpose and processes affected by scalability in the compiled process maps. Based on the qualitative analysis, a scope for the quantitative analysis was set, and is presented below.

5.1 Analysis of process mapping

In line with the focus of the report the analysis of the processes are focused on scalability in regards to how the volume is handled in the different departments, namely; Purchasing, Inbound deliveries, Outbound deliveries, and Claims and Returns.

5.1.1 Purchasing process

As is evident in the empirical chapter, the purchasing department has a fragmented area of responsibility. The purchasers are not only in charge of the administrative order call-offs but also the sole responsibility for market analysis in regards to what to have in the assortment in the respective category, when and how a campaign should be structured and the strategic role of conducting contracts and regular contact with the suppliers. As is shown in chapter 3.2, a more viable course of action would be to reduce the amount of processes and responsibilities placed on purchasing and increase their responsibility towards a more strategic purchasing role. Perhaps a big part of Jollyrooms success in its segment could be because of their used strategy, but it could just as easily hamper their future growth. As is evident by some statements from the qualitative data collection such as that there is a possibility to utilise an automated warning for when a product is about to run out of stock, but it is too time consuming to actually use it, indicates a time pressured environment. Another area of concern is how the purchasers are able to update purchase order's estimated time of arrival but it is neglected to the point where the receiving part of the organisation does not trust the stated dates on the purchase orders. Of course, this could also be related to a purchasing organisation with a focus towards sales and structuring campaigns. Which is also evident from the qualitative data collection, where the purchasing categories are measured based on monetary KPIs such as profit margins and products sold. Besides these KPIs there are few other management governed guidelines to follow, and as such, no regard toward the remainder organisation is pursued. The only guideline that is followed toward the warehousing is the categories warehousing budget, which is stated in monetary terms and not physical volume.

Another identified issue in the purchasing department regarding its impact on Jollyrooms scalability issue is their current use of lot sizes. The reasoning for this concern is the motivation behind them. As the sales rate of the products is manually conducted it is also time consuming. If a purchaser identifies the need for a resupply on a product where it would run out of stock based on historic data, the purchaser is recommended to place orders to cover several periods of demand without expressing a use of safety stock. Another lot sizing parameter is to reach a certain volume to be able to utilise the shipping alternative free shipping. Hence current lot sizing decisions are based on supplier demands and hunches.

5.1.2 Inbound deliveries

The planning environment at the inbound deliveries department is considered difficult. As is described above, other than the 30% of the suppliers notifying for a shipment there are no clear communication as to when goods is supposed to arrive. The inbound department has the ability to via SAP, see the purchasing orders with a stated delivery date, but as it rarely matches when the goods actually arrive it is not considered trustworthy information. Another dimension adding to this complexity is the varying amount of articles and pieces arriving each day. In the absence of a better routine, the inbound deliveries are kept in a two day buffer in order to better plan the man-hours needed for the following days as the employees are expensive to have simply standing around. This implies that the inbound deliveries are in need of more control over the inbound deliveries with a more stable flow of goods.

5.1.3 Outbound deliveries

If looking closer at the operational activities with a focus on the outbound deliveries there is clearly a risk of picking articles from the wrong storage location and thereby create an incorrect stock balance. This seems to be especially true if the same product is stored at two storage locations close to each other. The consequences of this could be not finding the desired product when the next order arrives, an issue that extends to affect the customer as the product cannot be delivered. Furthermore, problems related to the internal replenishment cycle within the warehouses sometimes occur when a replenishment request is sent out even though the stock level is not as low as is stated in SAP. These are complications that affect the efficiency of the logistical operations at Jollyroom. If taking into account a future growth of the company, there is a risk that these problems will occur more frequent as the orders, and thus the picking mistakes will increase. However, as of today the issue is not of that great importance since it is considered to be possible to remedy the incorrect handling by informing the staff about the effects.

5.1.4 Claims and returns

Since Jollyroom is present in Denmark, Norway, Sweden and Finland the handling and transport time varies. Given that Norway is not a member of the EU, higher demands are placed on customs handling which results in a longer lead time of the return flow. This in turn contributes to shorter time to handle the claim or return once it has reached Jollyroom, while it also means more administrative work. Thus, more pressure is put on the department when it comes to dealing with the customer errand within the promised time. Another issue that is present is the lack of a holistic perspective in terms of control over what has arrived. As of today there are many physical documents associated with each errand and there is not one universal system used. There is an ongoing project that aims to improve and link the current systems, with the intention of simplifying and make the work more efficient.

5.2 Lot sizing and safety stock

As the focal company currently decides the lot sizes or order quantities based on supplier given parameters or to fill TEUs, a basic and structured approach was used, the EOQ (Chapter 3.3.5). As the EOQ aims to calculate for the cheapest fixed lot size per order transaction and article, this provides a structured and illustrative contrast to the currently employed decision parameters.

As the demand per time unit (year) is given from the collected data, the ordering cost per order occasion and inventory carrying cost is calculated from the case specific data. To clarify on how the quantitative collected data is used see equation 11 and 12 below. The demand per time unit is given for each specific article, D.

The ordering cost per ordering occasion is estimated to 100 SEK for European supplied articles. This is based on the assumption that one purchase is estimated to take 15 minutes and the wages for a purchaser and purchasing assistant to range between 25 - 35 000 SEK/month, hence the wage per order can be estimated to 47 SEK. Handling cost per movement type/pallet is 7 SEK. Considering the varying lot sizes currently used, it was deemed difficult and time consuming to analyse every article, hence the 46 SEK extra to reach the used 100 SEK is seen a buffer in variation of load carriers and wages.

The order cost per ordering occasion for articles imported from Asia is estimated to 400 SEK. This is based on the same assumptions as above, with the difference that the transportation is not included in the product price, but in the ordering cost. The average price for one TEU during 2016 was according to the SCFI 2016 (see Appendix H) 691 US Dollars, which can be translated to SEK based on the USD - SEK currency rate visualised in Appendix I. Hence the average cost of 5917 SEK/TEU divided by the average of 20 articles received/TEU. To sum it up, ordering 47 SEK, handling the order 7 SEK, and transport 296 SEK leading to 350 SEK/order occasion with 50 SEK in buffer for a variation of load carriers and wages.

The inventory carrying cost per time unit is calculated based on the average holding cost per piece and month, X, multiplied by 12 and divided with C. By doing this the inventory carrying cost per time unit can be expressed in percent.

As the item value per stock unit is disclosed, it can be illustrated with table 3 in chapter "4.5.1 Classifications", where the price for product A 2.2 is C, hence the remaining article's price is equivalent to the given percentage of C, i.e. for product A 1.1, 32,35%.

$$\sqrt{\frac{2 \times D \times 100}{\left(\frac{Article\,\% \times X \times 12}{C}\right) \times (Article\,\% \times C)}} \quad (11)$$

Alternatively,

$$\sqrt{\frac{2 \times D \times 400}{\left(\frac{Article\,\% \times X \times 12}{C}\right) \times (Article\,\% \times C)}} \quad (12)$$

As there is limited consideration of safety stock in the focal company, and given that they are heavily dependent on having the right products in stock, there is a need to estimate this and identify how this would impact the scenario. To estimate the safety stock Equation 5 and 6 from chapter *3.3.3 Calculation of safety buffer* is used. This equation is selected due to its focus on not running out of stock during a replenishment cycle, and is hence argued to be the better option for the focal context. During 2016 Jollyroom was able to fulfill 99,6% of the demand and this service level was then used in the initial calculations. However, as the historic data illustrates, there are time periods with increased demand, usually around November and December. This gives a skewed standard deviation as the entire year is included. In order to better visualise what the safety stocks could look like for a year, an average of the standard deviation on the first ten months and the standard deviation for the last two is used. Another alteration used is where the demand for the product in a month is less than ten (mainly used for A- and B-products since the demands on C-products in general is lower), this is due to the illustrations of some products stock keeping levels where they could be interpreted as zero or simply very low inventories kept in stock, resulting in the low demand for some time periods. The lead time used in these calculations were given during the qualitative data collection and were estimated to 5 days for European suppliers and 90 days for Asian suppliers. Since the demand data is issued in a monthly basis, the lead times were divided by 30 to be expressed as months.

As the classification shows, the C-articles contribute with 10% of the volume value and a total of 84,6% of the products, a service level of 99,6% seems unreasonable for a company with a lack of space in its warehouses. Hence, a new service level was utilised for the classifications where A-products has a 99% service level, B-products with a 95% service level, and C-products at the relatively low 80% service level. The new service levels were discussed with the focal company and were deemed reasonable in the intention to illustrate what effects they would provide.

5.3 Analysis of classified products

For the proposed solution there were no restriction to the outgoing inventory balance. Instead every ingoing balance is set to be equivalent to the calculated safety stocks. In these calculations, only the movement types that results in a decrease of the inventory is used. Once a movement type would decrease the balance to a point under the safety stock, a lot size is added to the inventory balance. Hence, in the calculations and illustrations presented there is no consideration to the lead time of placing an order and receiving it. The calculations are therefore to be considered as a best case scenario, where orders are always placed just in time, not to take products from the safety stock.

These calculations and conditions explains why the built scenario's calculations and illustrations shows a high inventory balance where in the 'current state', the inventory balance can be seen as very low.

5.3.1 Analysis of A-products Europe & Asia

Figure 9 illustrates the result of ordering based on the initial EOQ-calculation. The fixed quantity equals a lot size of 171 pieces and the safety stock consists of 145 pieces. The average inventory level ends up at 225,29 pieces, which is a reduction by 27,1% compared with the original setting. Hence, the tied up capital reduces with the same percentage and the inventory turnover changes from 9,74 to 13,36.

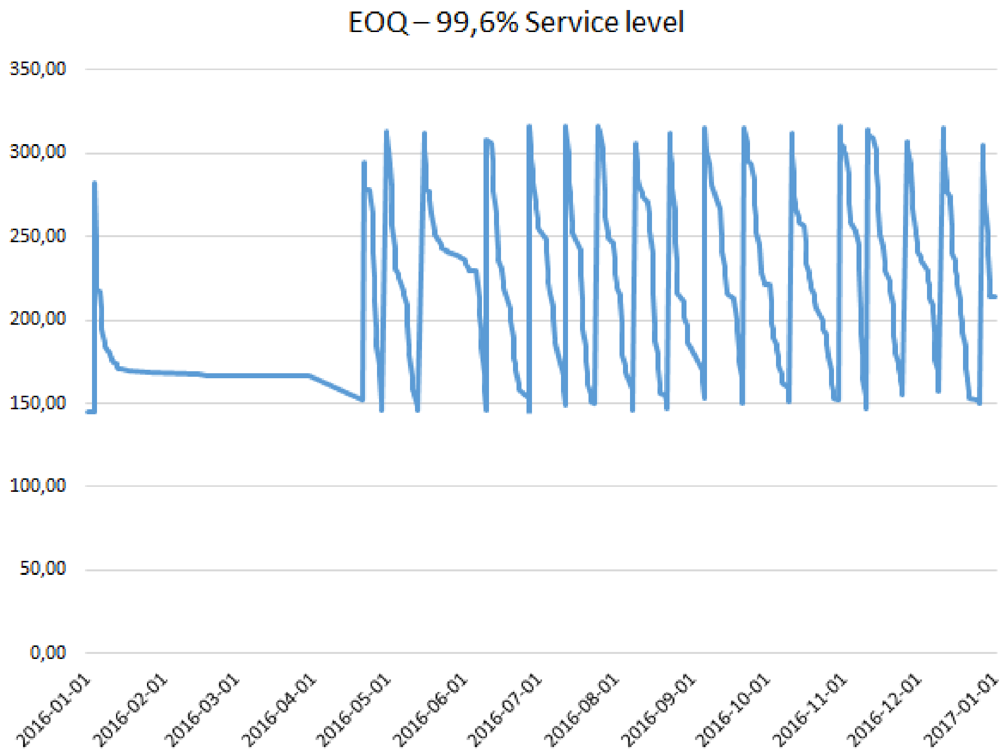


Figure 9. Illustrating the inventory levels with a fixed lot size and a safety stock based on 99,6% service level

Figure 10 shows the same fixed lot size of 171 pieces, but now also with a change in standard deviation and a reduced service level to 99%. Compared to the original settings of 2016, there is an average inventory reduction from 309,22 to 122,29 pieces. This also results in a reduction of 60,4% in tied up capital and an increased inventory turnover rate from 9,74 to 24,61.

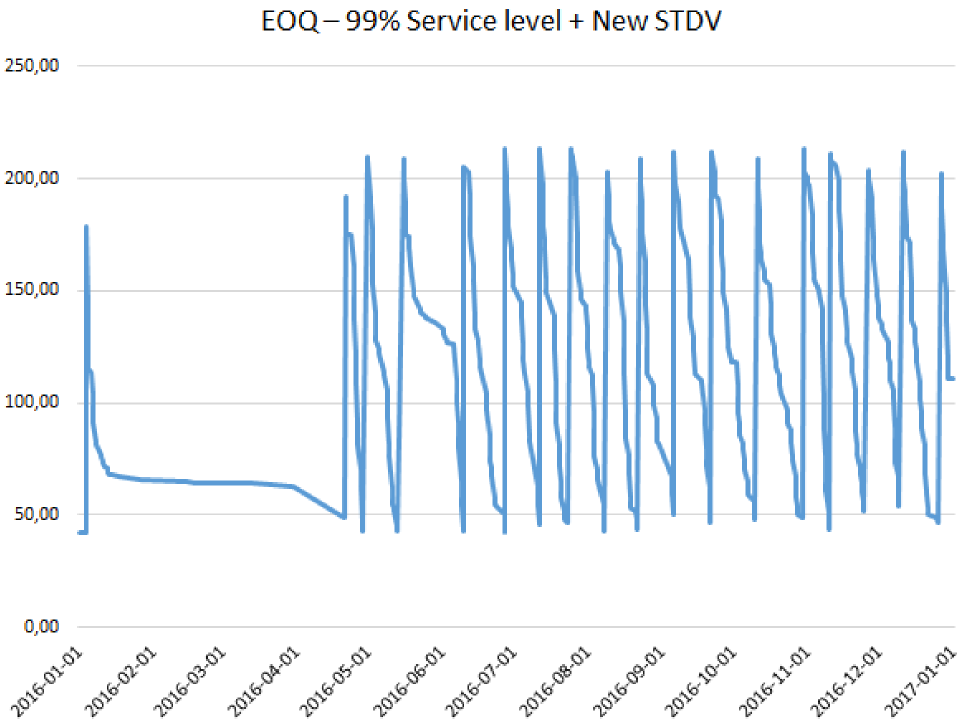


Figure 10. Illustrating the inventory levels with a fixed lot size and an adjusted safety stock level based on a 99% service level

5.3.2 Analysis of B-products Europe & Asia

Figure 11 illustrates the initial calculation, using a fixed lot size and a safety stock based on a 99,6% Service level. This gave a lot size of 16 and a safety stock of 2 pieces. The average inventory ended up at 10,20 pieces compared to the original 8,53 pieces, which results in a 19,6% increase in capital tied up in inventories for this product. The inventory turnover rate changed from 3,17 to 2,65.

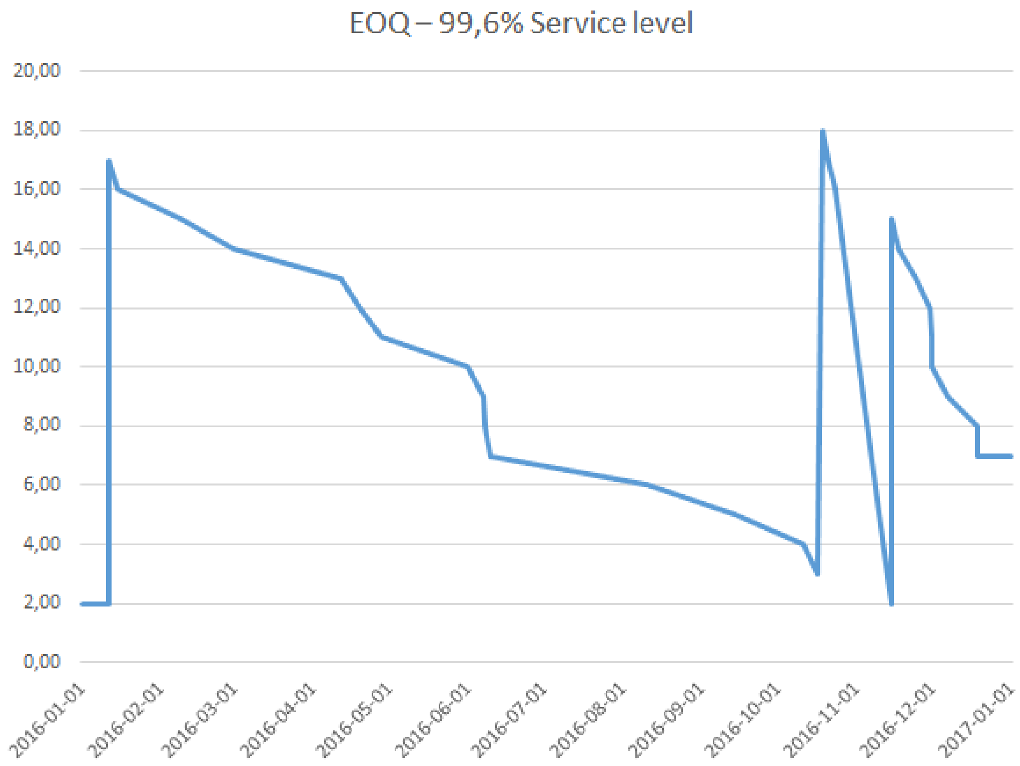


Figure 11. Illustrating the inventory levels with a fixed lot size and a safety stock based on 99,6% service level

Figure 12 illustrates the inventory levels with the same lot size as in figure 11, but with an altered standard deviation and reduced service level to 95%. In contrast to the actual levels of 2016, there is a slight deterioration of numbers such as a increase from 8,53 to 9,23 in average inventory as well as an increase of 8.2% in capital tied up. The inventory turnover rate changed from 3,17 to 2,93.

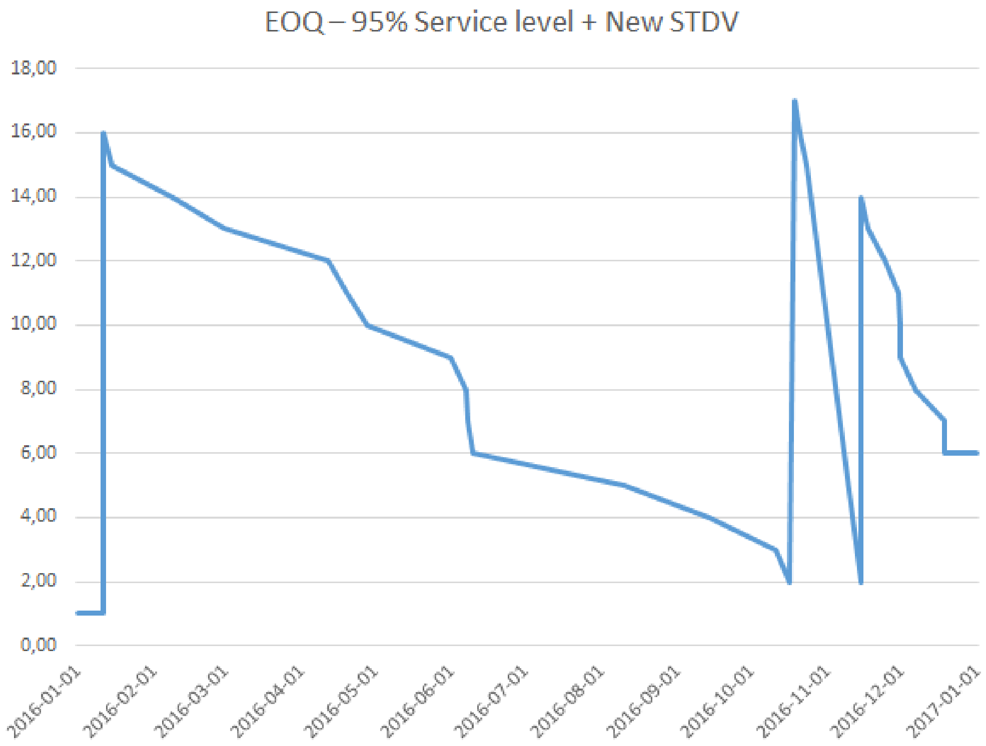


Figure 12. Illustrating the inventory levels with a fixed lot size and an adjusted safety stock level based on a 95% service level

5.3.3 Analysis of C-products Europe & Asia

Figure 13 illustrates what inventory levels could look like if the safety stock was based on a 99,6% service level. The safety stock in the figure below was calculated to 308 pieces with a lot size of 179. This illustration however indicates an increase in tied up capital of 91,4% and a reduction of inventory turnover from 3,96 to 2,07.

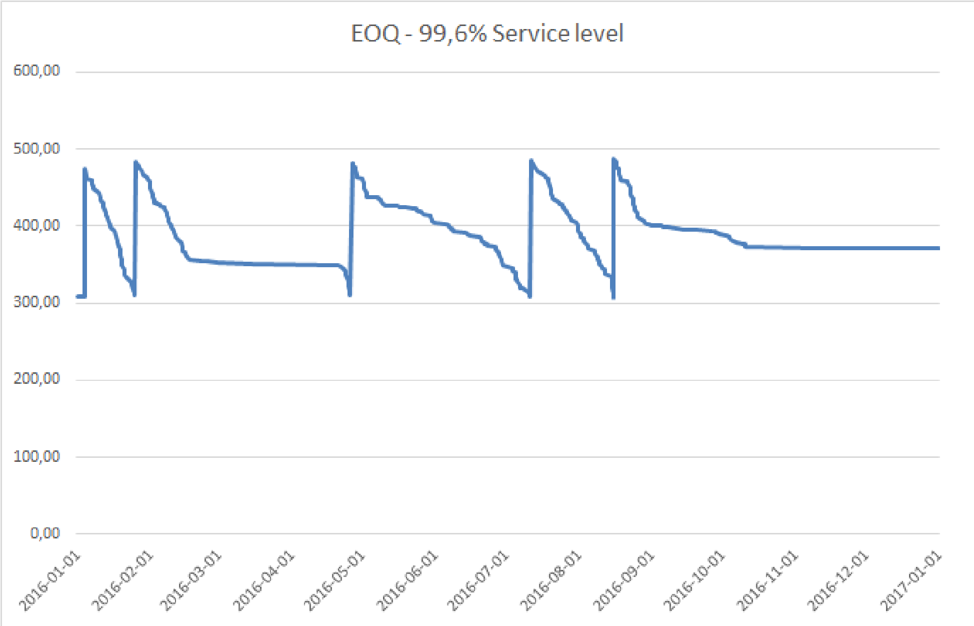


Figure 13. Illustrating the inventory levels for the selected product with a fixed lot size and a safety stock based on a 99,6% service level

Figure 14 below illustrates the inventory levels for the same product with a safety stock based on a service level of 80%. The safety stock with the new service level and adjusted standard deviation is calculated to 93 pieces. The average inventory decreases from 210 to 183,83, hence there is a reduction of tied up capital with 12,4% and an increase of inventory turnover from 3,96 to 4,51.

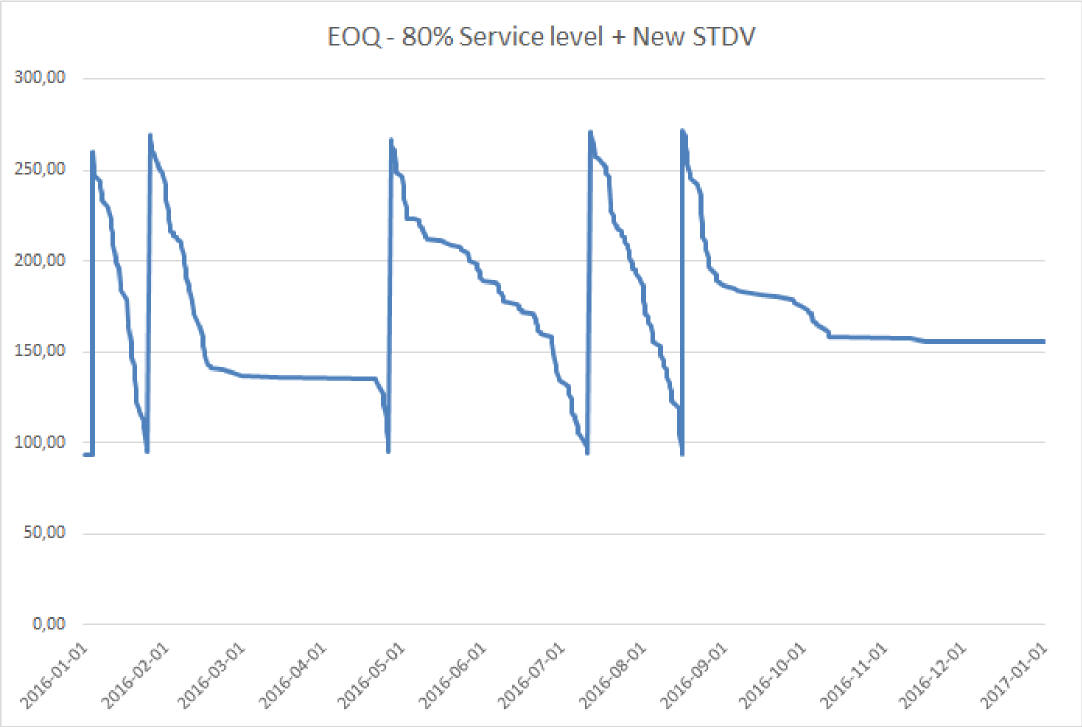


Figure 14. Illustrating the inventory levels for the selected product with fixed lot size and safety stock based on 80% service level

5.4 Compilation of classified products

When analysing the effect of using a fixed lot size with an adjusted service level for the sample products, the result somewhat varies between each product. By weighing its impact given its relative importance and merging the results for each individual A-, B-, and C-category it will be possible to draw more general conclusions. The result of doing so and transferring the outcome to the full product range can be seen in figure 15, below. In order to not disclose sensitive company data only percentages are shown in figure 15. There are several things that should be mentioned regarding the figure. First of all, there is a need to explain the underlying reasons why there is no common positive or negative link between the tied up capital and the inventory carrying cost for the B and C products. It turns out there is a small increase of tied up capital for the selected sample products that are from Europe. If instead considering the sample products from Asia, there is a quite big reduction. Since the articles from Europe represents a much larger part of the total assortment, the result of these are valued much higher compared to the articles from Asia. Hence, there is an increase of the total outcome. If also considering the inventory carrying cost it follows the same pattern as for the tied up capital. However, in this case the increase, seen as a percentage, is not that big for the European products which means that the reduction of the Asian products is of greater importance, even though they represent a much smaller part of the assortment. Thus, the result turns in favour for the EOQ-model.

A-products	From	To	
Tied up capital			-56%
Inventory carrying cost			-67%
Inventory turnover rate (times)			197%
Average inventory (m3)			-70%

B-products	From	To	
Tied up capital			17%
Inventory carrying cost			-33%
Inventory turnover rate (times)			-4%
Average inventory (m3)			-33%

C-products	From	To	
Tied up capital			4%
Inventory carrying cost			-6%
Inventory turnover rate (times)			-25%
Average inventory (m3)			-18%

Figure 15. Current figures and expected results if using a fixed lot size and an adjusted service level

As is also illustrated in figure 15 above, the result of the analysis for A-products show positive results, it should however be taken into consideration how relatively small amount of articles that contribute to these figures, see figure 16 below. When analysing the data in figure 15, they can be interpreted as that Jollyroom in the state of 2016 are focusing on stock-keeping its A-products and less for B- and C-products. Although, as the data also indicates, there are opportunities for improving the operations for the A-products.

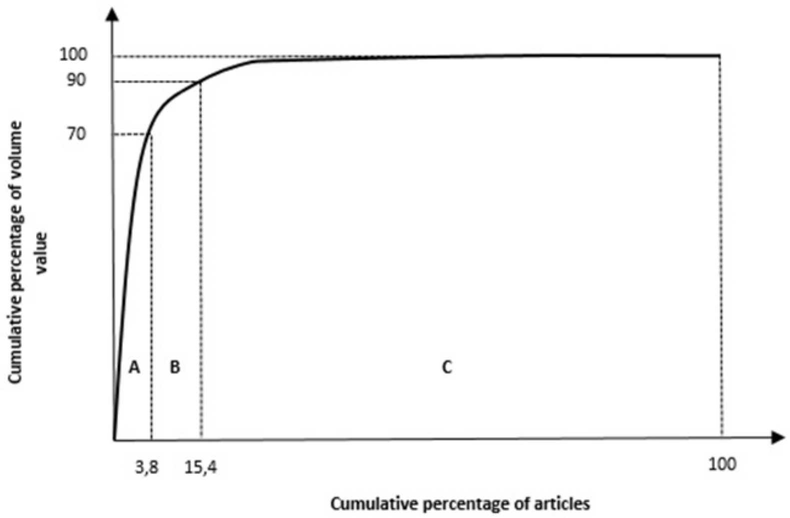


Figure 16. Illustrating the cumulative percentage of articles for the different classifications

Before generalising the result from figure 15 it is of importance to consider the number of articles representing each category, see figure 16 for illustration. As such the results weigh heavier from the C-products as there are more articles in this classification compared to B- and especially A-products. Despite this, the below generalised result indicates an opportunity for improvements in regards to warehouse management based on a structured lot size and safety stock, see figure 17. In order to not disclose sensitive company data only percentages are shown.

	From	To	Reduction	
Tied up capital			-	-25%

	From	To	Reduction	
Inventory carrying cost			-	-32%

	From	To	Increase (times)	
Inventory turnover rate				52%

	From	To	Reduction	
Average inventory				-55%

Figure 17. Compiled result of the classified products calculations.

6. CONCLUSION

The intention of this chapter is to summarise and highlight the findings of the study that are considered to be the most important. This will be done from a research question perspective where each of the two questions will be discussed separately.

RQ1: What are the key logistical processes and how are they affected by scalability at the focal company?

A mapping of the logistical processes was performed in order to get an understanding of the current situation and to be able to identify specific areas of interest for further analysis. By mapping parts of the organisation, the workflow and boundaries of the different departments was clarified. Furthermore, the physical flow of the products was defined and an awareness of related issues arose. It was realised that the purchasing department has a very wide responsibility both in terms of sales/campaigns and in optimising the purchases being made. Much of the focus is put on the purchasing price and the inventory carrying cost is often neglected. As the company has grown, the demands on the daily operations has increased in terms of receiving and delivering an increasing amount of products. One of the main issues of today is that much of the goods arrives unannounced, which results in difficulties in planning and managing the inbound flow. Furthermore, the coordination for reaching a levelled workload in terms of received deliveries throughout a day is deficient which makes the planning environment even more uncertain. To put forward demands on the suppliers and continuously monitor compliance is therefore seen as overlooked responsibilities. The combination of mixed tasks and an extensive workload together with the fast growth makes the purchasing function to an area of interest. Also, the fact that the ordering process is based on only estimated order quantities and that the work performed by the purchasing function affects the departments downstream in the organisation, suggest that this is where the focus of the report should be.

RQ2: How can the efficiency of the logistical processes be maintained or increased while the company is growing?

The report has mainly been focused on a quantitative analysis with regards to inventory management as it became evident that the purchasing function focuses more on the purchasing price and ordering cost rather than considering the costs involved in storing the products. Based on the data collected, a differentiation was made of the different articles with the volume value as a determining factor. A sample was chosen to illustrate how a more structured and theoretically established ordering strategy would affect the outcome of several commonly known KPIs such as tied up capital, inventory turnover rate and average inventory. The result from the quantitative analysis indicates that the inventory turnover would increase with 52% and that the average inventory would be reduced by nearly 55%. The outcome of the result thus suggests an improvement potential of two relevant KPIs that are of importance when trying to reduce or free up inventory space. What is further worth noting is that the analysed alternative solution involves safety buffers, unlike the current set-up where the extent to which sales are lost is unknown.

The purpose of the report was to identify how the focal company, currently suffering from scalability issues, could improve and make the current logistics setup more efficient and flexible before the investment in a new warehouse. This included identifying the key processes that are in need of attention in the current installations and what to consider in a future one.

By following a more structured approach that takes greater account of inventory carrying cost, the result suggest that ordered quantities should be reduced compared to the amount that is currently ordered. This, if combined with an increased frequency of placing the orders, would contribute to a maintained or improved opportunity to meet the demand since the safety buffer calculations deals with the variations in demand.

The increased inventory turnover implies that the products are not stored as long as before. This, from a flexibility point of view, would create better opportunities to make changes in the assortment. If also considering the increased inventory turnover from an efficiency perspective, it is likely that the products would not take up as many storage locations as before. Nor would some of the products no longer need to be placed at equally large storage bins given that the number of each SKU in inventory would be reduced. This would improve the ability to place the products at different locations and thereby increase the flexibility.

The reduced average inventory is also of importance when discussing efficiency and flexibility of the logistics setup. Since the result shows that the frequency of the orders would increase, it means that it would be possible to take advantage of combining both transport and inventory management in terms of developing a strategy for keeping inventory at sea. This would reduce the strain on the existing warehouse buildings and it would be possible to operate in a more efficient and flexible way.

7. DISCUSSION AND RECOMMENDATION

As the analysis indicate, there is room for improvement regarding tied up capital, inventory carrying costs, inventory turnover and volume. There are however some important aspects to consider in the presented analysis.

Regarding the EOQ calculations, the ordering cost per order occasion used is higher than the calculated cost in order to buffer for the varying handling costs once an order is received. This should be further specified and detailed in order to get a more accurate result of the ordering cost. As the volume data is expressed in its liquid volume, hence little regard to the different dimensions that are contributing to the volume of a product, it was proven difficult to analyse the number of pallets or TOs needed per shipment. A following step could be to with the calculated EOQ, analyse the actual pallets used for the calculated quantity and in a way, utilise trial and error until the actual order- and handling cost is identified. Another cost to be considered in the EOQ-calculations is the inventory carrying cost. The cost used in the calculations was given based on an average for all articles and quantities kept in the warehouses, without any regard to the articles volume. As the focal company suffers from limited warehouse space, it could be advantageous to have different inventory carrying cost for the different articles depending on its size. Thus, as is argued above, volume can be a considered an important variable, it would impact both the numerator value and denominator value in the EOQ-calculations. In order to clarify on how a volume parameter would impact the calculations an example is used. Looking back at the A-product A 1.2, which with the presented calculations had an ordering cost per order occasion estimated to 100 SEK, were the wage, handling and buffer are estimated according to what is presented in equation 13, presented below.

$$\sqrt{\frac{2 \times \ \mathrm{D} \times \ (\mathrm{Wage\ (47\ SEK) + Handling\ (7 * 1) + Buffer\ (46\ SEK)})}{\left(\frac{Article\,\% \ \times \ X \ \times \ 12}{C}\right) \times (Article\,\% \ \times C)}} = 171\, pcs \quad (13)$$

The equation resulted in an EOQ of 171 pcs. If the used volume parameter would be doubled, as in equation 14 below, were the handling and the inventory carrying cost are doubled, the EOQ results in 125 pcs, a 26,9% decrease.

$$\sqrt{\frac{2 \times \ \mathrm{D} \times \ (\mathrm{Wage\ (47\ SEK)} + \mathrm{Handling\ (7 * 2)} + \mathrm{Buffer\ (46\ SEK))}}{\left(\frac{Article\,\% \ \times \ X \ \times 2 \ \times \ 12}{C}\right) \times (Article\,\% \ \times C)}} = 125\,pcs \quad (14)$$

Similar calculations can be performed for products with a smaller volume, for instance article C 2.1. If the used volume parameters would be reduced by half, the calculated EOQ of 168 pcs, illustrated in equation 15 below, would be increased to 256 pcs, an increase of 52,4%.

$$\sqrt{\frac{2 \times \ D \ \times \ 400}{\left(\frac{Article\,\% \ \times \ X \ \times 0{,}5 \ \times \ 12}{C}\right) \times (Article\,\% \ \times C)}} = 256\,pcs \quad (15)$$

Another parameter to be taken into consideration is the safety stock calculations. As the used calculations has served as indications, a more accurate safety stock could be calculated. For instance, instead of utilising an average of the standard deviations from month 1-10 and 11-12, it could prove more accurate to have separate safety stock values during these two periods.

As the report's purpose was to identify and move the focal company away from some of its scalability issues regarding the volumes handled and stored in its facilities, Jollyroom is recommended to utilise this study as an indication for the use of new purchasing strategy.

As the report suggests, there are multiple benefits to reap from structured lot sizing as well as a safety stock to increase the availability of products to customers.

- If Jollyroom were to utilise the structured approach presented in the report there needs to be a consideration regarding the different inventory carrying costs based on the sizes of products as well how stocked the warehouses are, as this will give a more accurate result and avoid orders to reach maximum capacity of the warehouses. Of the classified products selected in the report, the average volume for A-products is 0,1239 m^3, 0,0278 m^3 for B-products and 0,0053 m^3 for C-products. Hence, in order to reduce the carried inventory quickly is to increase the inventory carrying cost for the averagely bigger A-products, but this needs balancing as these products are also the most profitable, hence a solution for a longer term would be to balance the inventory carrying cost based on volume of the product, and weight the B- and C-products, more heavy than A-products.

- Another way to reduce the carried inventory of slow-moving B- and C-products is to further decrease the ordering cost for these products. The B- and C-products could hence be considered as a bigger cost for the company. This will reduce the order quantity and force these purchases to be more frequent with smaller ordered quantities.
- The purchasing department are further urged to increase its cooperation between the categories, as well as shift towards a strategic purchasing organisation. As the scenarios are not considering the least amount of goods required to be able to place an order (mainly Asian suppliers), a strategic purchasing organisation, can initialise valuable supplier relationships and thereby assert pressure on lower quantities and/or more frequent deliveries, which currently is a viable option since the shipping partner offers the service buyers council.

As the company has grown, some of the purchasing activities seem to be stuck in the same purchasing patterns as when the company was smaller, a pattern that very well could be the reason to why the company is where it is today. However, if this pattern is not broken, the one new warehouse will not be a sustainable long term solution as the purchasing quantities and articles are assumed to grow alongside the company. The suggestion is hence to acknowledge the real issue, and not solve issues by firefighting and adding additional storage facilities.

REFERENCES

Axsäter, S. (2006). *Inventory control.* 1st ed. New York: Springer.

Cho, Y.H. & Kim, J.K. 2004, Application of Web usage mining and product taxonomy to collaborative recommendations in e-commerce, *Expert Systems With Applications,* vol. 26, no. 2, pp. 233-246.

Crandall, R., Crandall, W. and Chen, C. (2010). *Principles of supply chain management*. 1 ed. Boca Raton, Fla.: CRC.

Damelio, R. (2011). *The basics of process mapping*. 1st ed. New York: Productivity Press/Taylor & Francis Group.

Damron, T., Rupp, W. and Smith, A. (2016). Inventory control in the retail sector: case studies of best business practices. *International Journal of Procurement Management*, 9(3), p.354.

Eisenhardt, K.M. (1989), Building Theories from Case Study Research. *The Academy of Management Review*, vol. 14, no. 4, pp. 532-550.

Gülşah Hançerlioğulları, Alper Şen, Esra Ağca Aktunç, (2016) Demand uncertainty and inventory turnover performance: An empirical analysis of the US retail industry. *International Journal of Physical Distribution & Logistics Management*, Vol. 46 Issue: 6/7, pp.681-708.

Jessop, D. Morrison, A. (1994) *Storage and supply of materials: inbound logistics for commerce, industry and public undertakings.* Pitman, London.

Jonsson, P. and Mattsson, S. (2009). *Manufacturing, planning and control*. 1st ed. Maidenhead: McGraw-Hill Higher Education.

Jonsson, P. and Mattsson, S. (2011). *Logistik*. 1st ed. Lund: Studentlitteratur.

Keller, J., Jacka, M. (1999). Process mapping. *The Internal Auditor,* Vol. 56, no. 5. pp.60-64.

de Koster, R. (2002). The Logistics Behind the Enter Click. *Lecture Notes in Economics and Mathematical Systems*, pp.131-148.

Mattsson, S-A. (2008) Välja lämplig servicenivådefinition och beräkna säkerhetslagret från denna definition. *Lagerstyrningsakademin.* http://lagerstyrningsakademin.se/artikel%20x-2.html [2017-04-11]

Mattsson, S-A. (2009) Uppskatta ordersärkostnader för inköpsartiklar. *Lagerstyrningsakademin.* http://lagerstyrningsakademin.se/Hbok%20D/d01_metod_for_bestamning_av_orderkvantiteter.pdf

Mattsson, S-A. (2017) Uppskatta ordersärkostnader för inköpsartiklar. *Lagerstyrningsakademin.* http://lagerstyrningsakademin.se/Hbok%20B/b11_ordersarkostnader_for_inkopsartiklar.pdf

Menasce, D. (2000). Scaling for e-business. *Proceedings 8th International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems.*

Oxford Dictionaries. (n.d) https://en.oxforddictionaries.com/definition/scalability [2017-03-15].

Postnord. (2016) *E-handeln i Europa 2016*. http://www.postnord.com/globalassets/global/sverige/dokument/publikationer/2016/e-handeln-i-europa-2016.pdf (2017-02-24).

Sarwar, B., Karypis, G., Konstan, J. and Riedl, J. (2000). Analysis of recommendation algorithms for e-commerce. *Proceedings of the 2nd ACM conference on Electronic commerce - EC '00*.

Stock, J.R. & Lambert, D.M. 2001, *Strategic logistics management.* 4th ed, McGraw-Hill/Irwin, Boston, Mass.

Teunter, R., Babai, M. and Syntetos, A. (2009). ABC Classification: Service Levels and Inventory Costs. *Production and Operations Management*, 19(3), pp.343-352.

Toomey, J. (2003). *Inventory management*. 1st ed. Boston: Kluwer Academic.

Van Weele, A. (2015). *Purchasing & supply chain management*. 1st ed. Australia: Cengage Learning.

Yin, R.K. (2009). *Case study research: design and methods.* 4th ed, Sage, Thousand Oaks, CA.

X-rates (n.d). http://www.x-rates.com/average/?from=USD&to=SEK&amount=1&year=2016 (2017-05-02).

APPENDIX A – NORMAL DISTRIBUTION TABLE

Safety factor	Service level %	Safety factor	Service level %	Safety factor	Service level %	Safety factor	Service level %
0,00	50,0	0,72	76,4	1,44	92,5	2,16	98,5
0,02	50,8	0,74	77,0	1,46	92,8	2,18	98,5
0,04	51,6	0,76	77,6	1,48	93,1	2,20	98,6
0,06	52,4	0,78	78,2	1,50	93,3	2,22	98,7
0,08	53,2	0,80	78,8	1,52	93,6	2,24	98,7
0,10	54,0	0,82	79,4	1,54	93,8	2,26	98,8
0,12	54,8	0,84	80,0	1,56	94,1	2,28	98,9
0,14	55,6	0,86	80,5	1,58	94,3	2,30	98,9
0,16	56,4	0,88	81,1	1,60	94,5	2,32	99,0
0,18	57,1	0,90	81,6	1,62	94,7	2,34	99,0
0,20	57,9	0,92	82,1	1,64	94,9	2,36	99,1
0,22	58,7	0,94	82,6	1,66	95,2	2,38	99,1
0,24	59,5	0,96	83,1	1,68	95,4	2,40	99,2
0,26	60,3	0,98	83,6	1,70	95,5	2,42	99,2
0,28	61,0	1,00	84,1	1,72	95,7	2,44	99,3
0,30	61,8	1,02	84,6	1,74	95,9	2,46	99,3
0,32	62,6	1,04	85,1	1,76	96,1	2,48	99,3
0,34	63,3	1,06	85,5	1,78	96,2	2,50	99,4
0,36	64,1	1,08	86,0	1,80	96,4	2,52	99,4
0,38	64,8	1,10	86,4	1,82	96,6	2,54	99,4
0,40	65,5	1,12	86,9	1,84	96,7	2,56	99,5
0,42	66,3	1,14	87,3	1,86	96,9	2,58	99,5
0,44	67,0	1,16	87,7	1,88	97,0	2,60	99,5
0,46	67,7	1,18	88,1	1,90	97,1	2,62	99,6
0,48	68,4	1,20	88,5	1,92	97,3	2,64	99,6
0,50	69,1	1,22	88,9	1,94	97,4	2,66	99,6
0,52	69,8	1,24	89,3	1,96	97,5	2,68	99,6
0,54	70,5	1,26	89,6	1,98	97,6	2,70	99,7
0,56	71,2	1,28	90,0	2,00	97,7	2,72	99,7
0,58	71,9	1,30	90,3	2,02	97,8	2,74	99,7
0,60	72,6	1,32	90,7	2,04	97,9	2,76	99,7
0,62	73,2	1,34	91,0	2,06	98,0	2,78	99,7
0,64	73,9	1,36	91,3	2,08	98,1	2,80	99,7
0,66	74,5	1,38	91,6	2,10	98,2	2,82	99,8
0,68	75,2	1,40	91,9	2,12	98,3	2,84	99,8
0,70	75,8	1,42	92,2	2,14	98,4	2,86	99,8

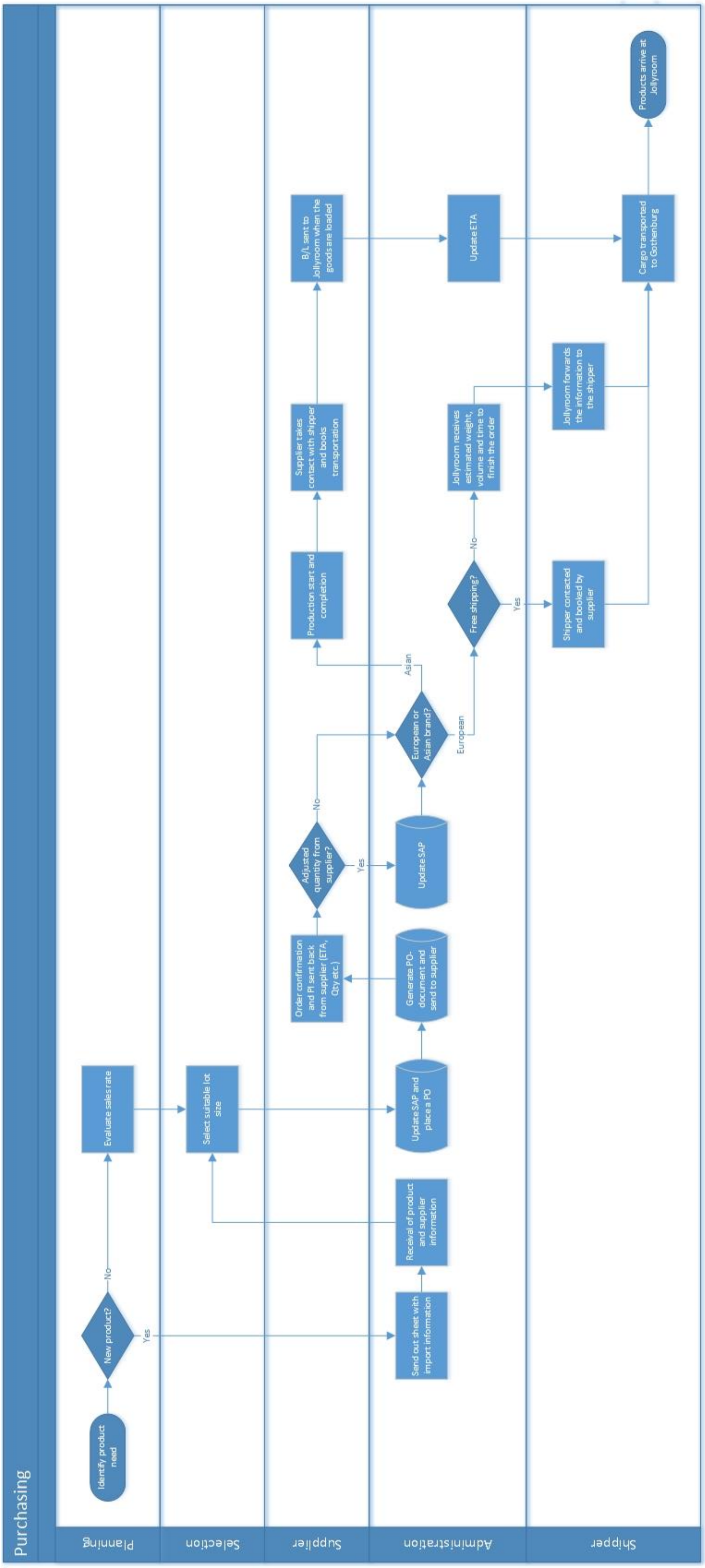
APPENDIX B – ORDERING COSTS

Request for quotation	Good reception
Supplier negotiation	Inspection at arrival
Selection of supplier	Placement in stock
Purchase order/ order proposal	Arrival reporting
Purchase order processing	Internal transports
Delivery monitoring	Invoice check
Other supplier contacts	Payment
External transports	

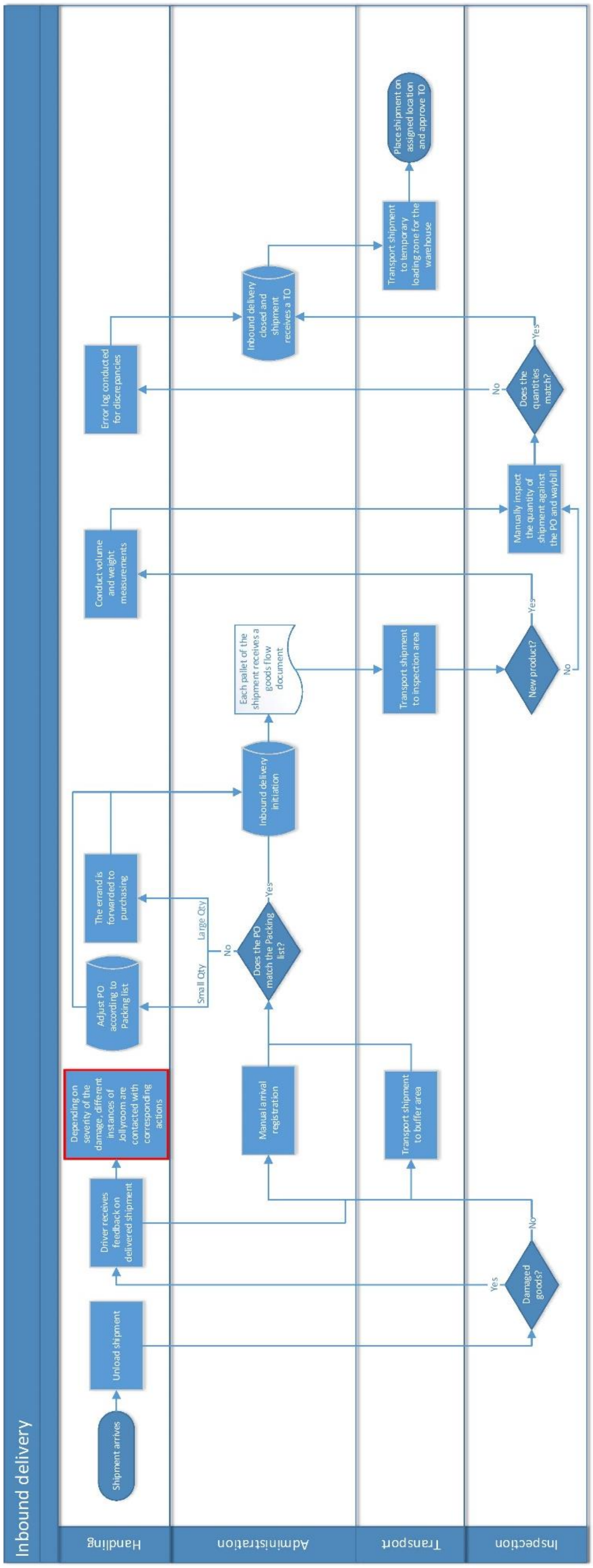
APPENDIX C – INVENTORY CARRYING COSTS

Capital cost	Cost for depreciation
Cost for premises	Cost for stocktaking
Cost for shelves, racks, etc.	Administrative costs
Handling equipment costs	Data processing costs
Handling costs	Staff management
Insurance costs	

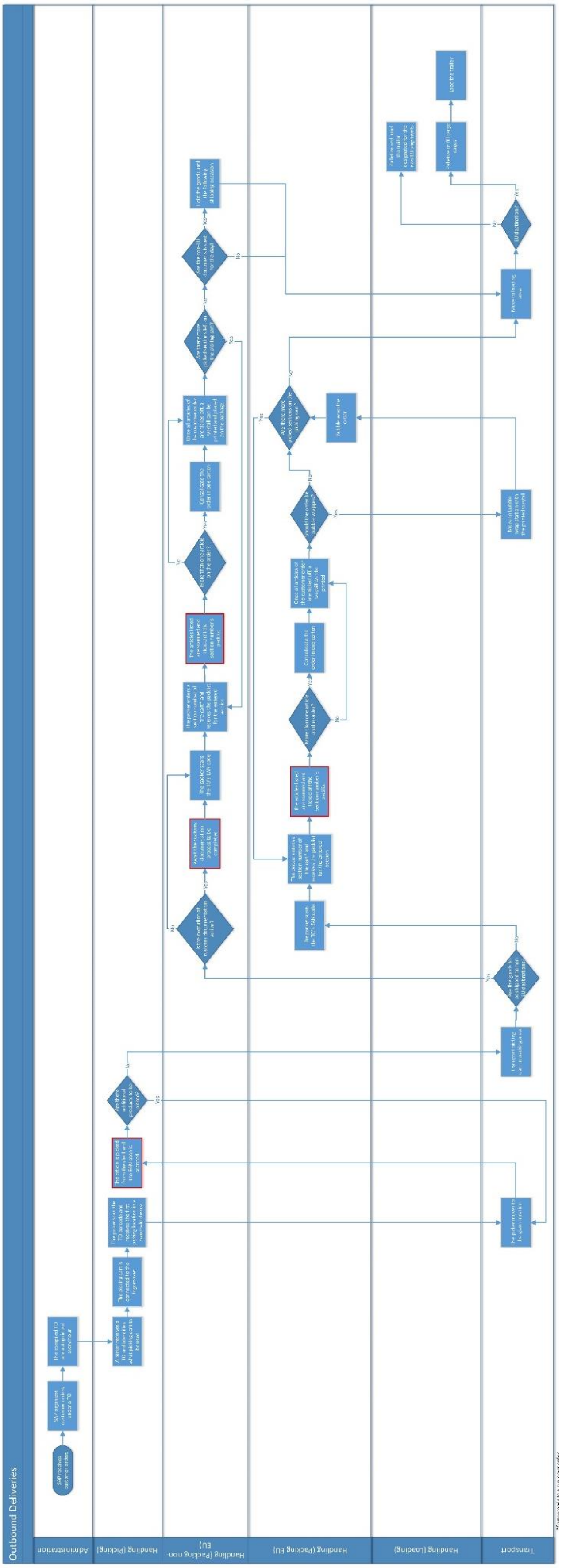
APPENDIX D – PURCHASING



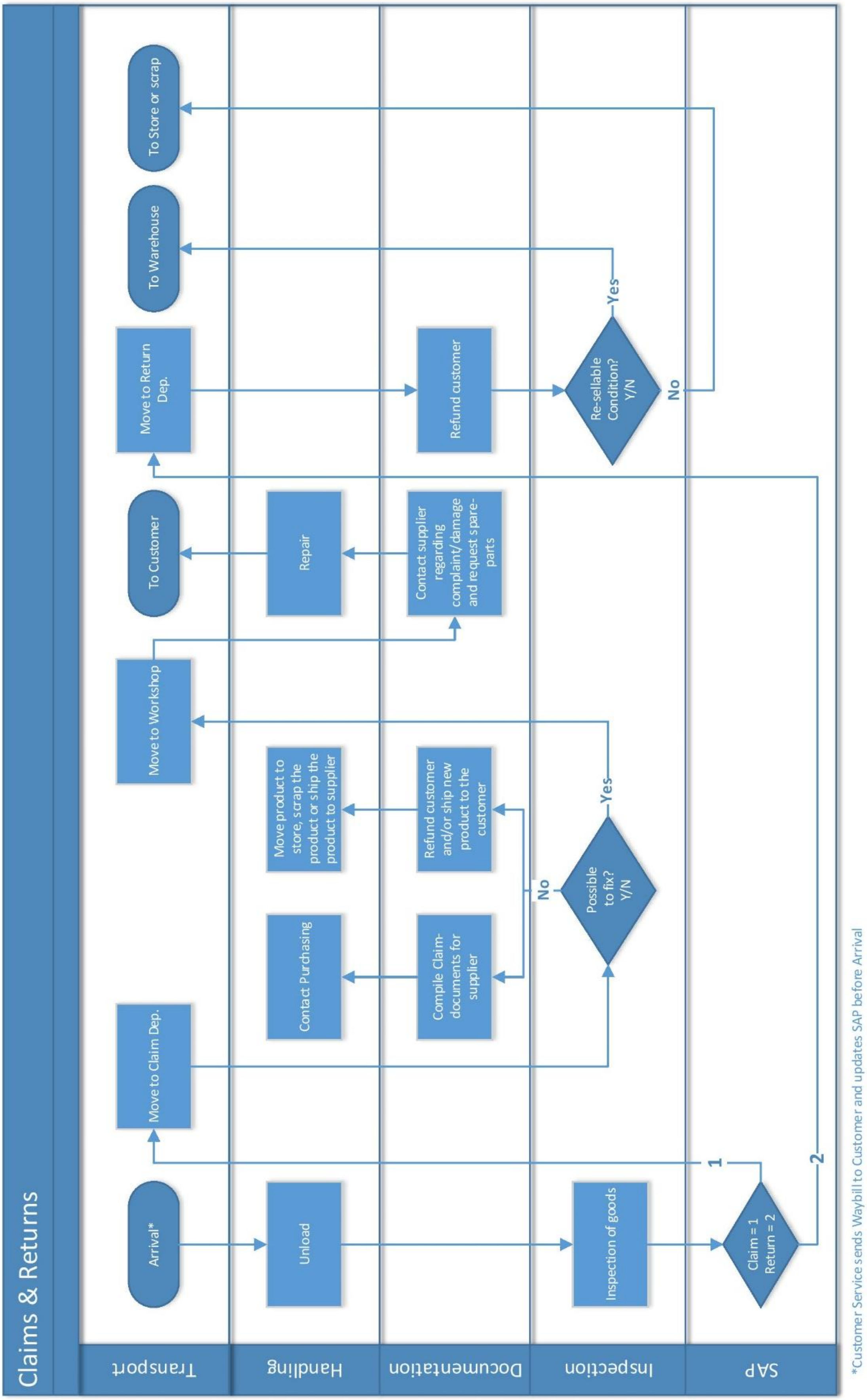
APPENDIX E – INBOUND DELIVERY



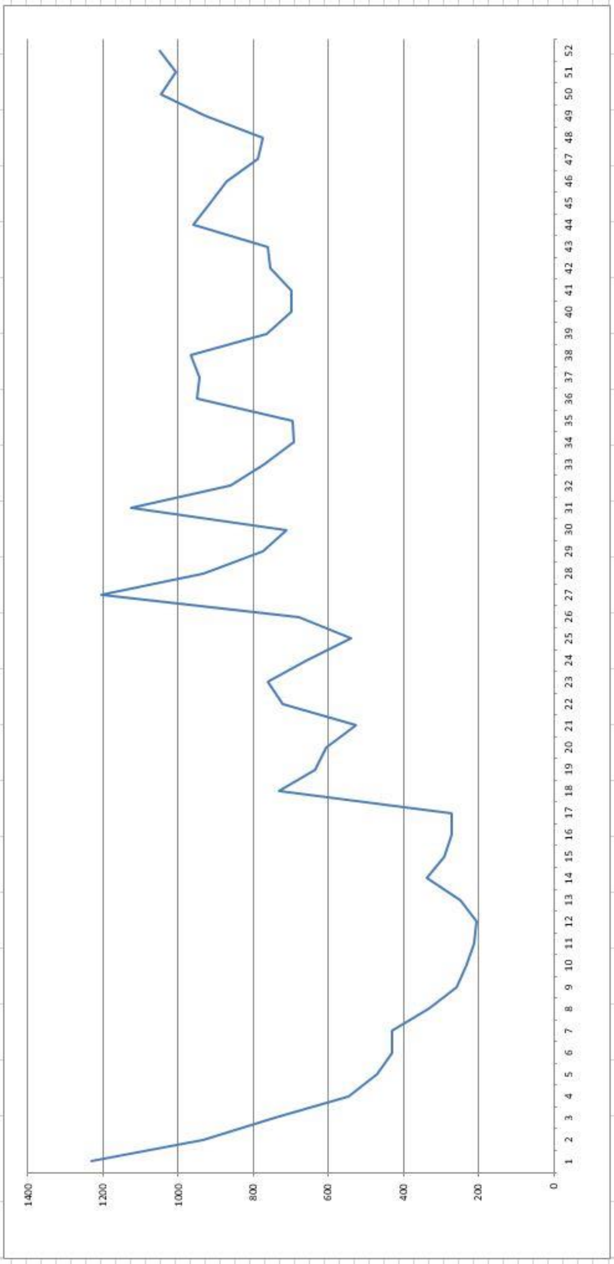
APPENDIX F – OUTBOUND DELIVERY



APPENDIX G – CLAIMS & RETURNS



APPENDIX H – SHANGHAI CONTAINERIZED FREIGHT INDEX



	Shanghai Containerized Freight Index		
	Europe (Base Port)	USD/TEU	Compare with last week
	week 1	1232	659
	week 2	932	-300
	week 3	740	-192
	week 4	545	-195
	week 5	469	-76
	week 6	431	-38
	week 7	431	0
	week 8	332	-99
	week 9	257	-75
	week 10	231	-26
	week 11	211	-20
	week 12	205	-6
2016	week 13	247	42
	week 14	339	92
	week 15	291	-48
	week 16	271	-20
	week 17	271	0
	week 18	732	461
	week 19	636	-96
	week 20	606	-30
	week 21	527	-79
	week 22	720	193
	week 23	761	41
	week 24	657	-104
	week 25	540	-117
	week 26	680	140
	week 27	1206	526
2016	week 28	932	-274
	week 29	776	-156
	week 30	713	-63
	week 31	1125	412
	week 32	861	-264
	week 33	771	-90
	week 34	691	-80
	week 35	695	4
	week 36	949	254
	week 37	943	-6
	week 38	966	23
2016	week 39	764	-202
	week 40	699	-65
	week 41	699	0
	week 42	755	56
	week 43	761	6
	week 44	958	197
	week 45	913	-45
	week 46	869	-44
	week 47	788	-81
	week 48	775	-13
	week 49	930	155
	week 50	1046	116
	week 51	1006	-40
	week 52	1049	43

YEAR AVERAG	691

APPENDIX I – AVERAGE SHIPPING COST FROM USD TO SEK

Month	Currency (USD)	Currency (SEK)
January	691	5906
February	697	5858
Mars	707	5769
April	727	5610
May	718	5685
June	711	5741
July	690	5918
August	697	5853
September	692	5899
October	671	6085
November	646	6314
December	641	6365
Average	691	5917