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Enhancement of Short Term Demand Planning in Highly Dynamic Supply Chains

A case study at a pharmaceutical distributor

Master Thesis in Supply Chain Management

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Department of Technology Management and Economy
Division of Supply and Operations Management
CHALMERS UNIVERSITY OF TECHNOLOGY
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MASTER'S THESIS E2017:002

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ABSTRACT

Competition between supply chains is high on today's market. In order for a supply chain to stay competitive, all companies within the supply chain have to evaluate and improve their own performance. In addition to an increasingly competitive market, market elements that are highly dynamic are affecting the performance of supply chains. Increasing globalization and increasing requirements from customers, are contributing to uncertainty in demand and complicates the performance of the supply chains.

In order for companies to handle uncertain demand, planning activites are executed. Demand planning is a measure that can be used to forsee future demand, for example through forecasting activities. However, inaccuracy in demand planning has effect on the operational activities in a firm, and can lead to excessive stock or stockouts. Therefore, demand planning-activities should be based on customer requirements and carefully executed.

The purpose of this research was to identify elements that are contributing to a dynamic supply chain from a distributors perspective, and identify what areas that can be improved in order to maximize the business performance of the company. The research was performed as a case study at a large Swedish pharmaceutical distributor with the aim to improve the business performance at the case site.

The method used in the research was explorative, where quantitative and qualitative methods were combined to collect relevant information, and then sort the information essential for the research. Interviews were the most important method for the qualitative data collection, and they were complemented with quantitative data from the case site's internal databases and ERP-systems.

The result of the research included mapping of the most essential elements that are contributing to the dynamic environment at the case site. The research also contained an evaluation of the currently used systems for demand planning and identification of improvement areas for the systems, as well as recommendations of how to improve the usage of the current methods and systems.

Keywords: short term planning, demand planning, uncertain demand, fluctuating demand

ACKNOWLEDGEMENTS

This master thesis was conducted during the autumn semester 2016 and the beginning of the spring semester 2017, as a final part of the master program Supply Chain Management at Chalmers University of Technology. The project was conducted in collaboration with a student from Luleå Technical University, and the reserach was initiated and performed at a large pharmaceutical distributor in Sweden.

Primarily, I would like to thank the pharmaceutical distributing company for providing the opportunity to conduct the research with them. I would like to thank the supervisor at the company who has contributed the research with ideas and feedback, as well as the other employees at the company that have participated in interviews and provided knowledge and expertise to the research. Finally, I would also like to thank Kjell Rask, my master thesis supervisor from Luleå Technical University, for his support and feedback during the research.

Gothenburg, January 2017

Nadia Nuldén

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DEFINITIONS AND ABBREVATIONS

CW – Central Warehouse

DC – Distribution Centre

DC1 – Distribution Centre 1 at the Case Site

DC2 – Distribution Centre 2 at the Case Site

DC3 – Distribution Centre 3 at the Case Site

ERP-system – Enterprise Resource Planning System

PoM – Product of the Month

ROP – Re-order Point

ROQ – Re-order Quantity

SG – Substitution Group

SKU – Stock Keeping Unit

SS – Substitution System

TLV – The Dental and Pharmaceutical Benefits Agenecy (Tandvårds-och läkemedels-förmånsverket)

TPL – Third Party Logistics Provider

1. INTRODUCTION

This chapter provides an overall description of the research. Initially, the background to the research is described where the context of the topic is explained as well as the interrelation the research topic has to overall business performance of supply chains. The chapter also includes a description of the case site, the product of the month and the substitution system. These subsections present terms that are essential for the research and for the comprehension of the thesis. Afterwards, the introduction presents the purpose of the research, the research questions, the scope of the study, and the structure of the report.

1.1 BACKGROUND

The competition between supply chains on today's market is increasing, due to for example globalization, individualized requirements from customers, enhanced cooperation within supply chains and improved companies' business strategies. Supply chains are getting more complex and improving their performance, hence the competition on the market is increasing. In order for a supply chain to stay competitive the performance of each company in the supply chain has to be continuously evaluated and improved (Lee, 2002; Gupta & Maranas, 2003). In order for a company to optimize their supply chain performance a strategy based on customer requirements should be developed (Chopra & Meindl, 2013).

Since competition on the market and requirements from customers are increasing, companies are facing a growing uncertainty of demand. In order for companies to plan for the future and forsee future demand on a market where demand is highly uncertain, planning activities are executed. Inaccurate planning have negative influence on operational activities, hence the planning activities are of high importance. Inaccurate planning can lead to inventory stockouts and hence loss of sales, or excessive stock which entails tied up capital (Chopra & Meindl, 2013). To manage the demand uncertainty, forecasts can be used as a measure in order to forsee the future demand (Axsäter, 2015). Depending on the structure of the demand uncertainty the demand planning horizon are varying. Short term planning includes a horizon of only a few days up to three months, while mid term and long term includes a longer time horizon (Fleischmann, Meyr, & Wagner, 2005).

The supply chain of pharmaceuticals is one example where parts of the supply chain meets demand that is highly fluctuating and hence uncertain. The demand of some of the products in this supply chain are highly fluctuating monthly, and therefore only short term demand planning are executed for these products. The reason for the fluctuating demand for these products is a system, initiated by the government that facilitates competition between manufacturers, and results in variation of which pharmaceutical that has the lowest price. The system includes a monthly tender where the prices are decided. This reserach has focused on the role of the pharmaceutical distributor in this supply chain and the challenges that arises from the uncertain demand and the short term demand planning that follows.

1.2 THE CASE SITE

The case site is the largest pharmaceutical distributor in Sweden. They are a part of a group that is one of the largest pharmaceutical distributors in the world. The case site is a third party logistics firm and their core competence is within logistics. The service portfolio offered to customers consists of services related to stock-keeping,

distribution and inventory control and they are cooperating with more than one hundred pharmaceutical manufacturers, with most of them a close relationship is established. Most commonly, the manufacturers outsource entire logistics functions to the case site, which means that the manufacturing companies and the case site have integrated service agreements, see definition in subchapter 2.2. Every day more than one thousand pharmacies in Sweden receive products that are distributed by the case site. The pharmaceutical distributors in Sweden have to follow certain legislation, which for instance includes that the pharmacies should receive their products within 24 hours after the order is placed, i.e. a maximum lead time of 24 hours. This means that pharmaceutical distributors has to receive the order, process it, include it in the daily operation schedule, pick the order, and distribute it within this time. Hence, the distributors must be flexible in order to meet legislation and demand. The case site's customers are pharmaceutical manufacturers, and the pharmaceutical manufacturers' customers are pharmacies. The pharmaceutical consumers are the end customers, which consists of the customers to the pharmacies. The main goal in the supply chain is to make improvements for the end customer, hence all stakeholders have an end-customer-perspective.

The case site has three central warehouses (CW) in Sweden. The distribution centers (DC) are as well located in three different locations, and will be referred to as DC1, DC2, and DC3 in this report. In combination with DC1, the head office is situated. In total, the case site has over 500 employees in Sweden. The case company consider themselves as an independent actor who is striving to meet requirements from end customers, pharmacies, pharmaceutical manufacturers, as well as hospitals and their patients, in order to satisfy their requirements and fulfill their demands. The case site also focuses highly on meeting the requirements and legislation initiated by the government. The case site handles more than 15,000 SKUs, where more than 3,000 SKUs are generical pharmaceuticals and part of the substitution system (SS). The concept of SS will be described in section 1.3.

The SKUs that are a part of the SS have in general high demand uncertainty and low supply uncertainty, this will be further described in section 1.3. Due to the rules and legislation pharmaceutical manufacturers have to adapt to, the risk of having shortage of supply is low. A shortage in supply can as well lead to loss of direct and possible future sales and hence this is also influencing the low risk of shortage in supply. A shortage in supply could lead to a decreased customer perception, thus the risk of shortage are minimized. The demand is difficult to predict, due to for example the highly varying demand for pharmaceuticals, the change of customer behaviour and increasing competition on the market. The demand uncertainty leads to a complex demand planning environment, where the risk of stock-outs is minimized by using safety stocks. This leads to a situation in which over-stocks are nearly inevitable.

Pharmaceutical distributors have certain rules and legislation to follow, and they have to adapt the distribution of products that require specific handling, such as cold, heat, extra careful treatment or minimal vibration. The distributors are also handling narcotics, which has additional legislation that further complicates the handling. Pharmaceuticals within this category have an increased risk of theft, for example during transportation, hence extra security is required. Since the case site is handling pharmaceuticals, an absolute traceability through the whole supply chain is required. It is of high importance that the origin and distribution of pharmaceuticals are possible to track, for example to ensure that consumers can safely use their products.

The case site has several incoming and outgoing flows that are controlled by different actors. In the CW, the pharmaceutical manufacturers controls the stock levels themselves and have responsibility for the inventory levels and replenishment policies. Most commonly the manufacturers are having large stocks at the CW in order to minimize the risk of inventory facing stock-out. Another reason is that the pharmaceutical manufacturers are, in general, producing the SKUs in batches, which means that the CWs at the distributors are replenished once a batch is produced.

When the stock levels in DC needs to be replenished, the case company is responsible of determining the quantity of products that has to be transferred from the CW to the DC. The flow from CW to DC is referred to as an internal flow. The flow occurs between all the CWs and DCs at the case site depending which facility that are in need of replenishment. The time to make the transfer of products and the quantity of products to transfer is referred to as re-order point (ROP) and re-order quantity (ROQ). The methods used to calculate and decide these levels will be described in section 4.1. The quantities and the time for making the transfer is important since the DCs has limited floor space. This means that a large transfer of products, that is not properly calculated and evaluated with current needs, can lead to a large quantity of products occupying room in the DC without having any demand during the time period. Once the transfer is performed, the case site is owning the products themselves and in general no products are transferred back from DC into CW. An excessive quantity of products in the DC will hence occupy room, and entail that other products that are demanded can not be stored due to lack of space and contribute to costs such as tied up-capital.

At the case site, the external incoming flows are controlled by the pharmaceutical manufacturers and distributed to the CWs. In some situations, the pharmaceutical manufacturers are directly distributing their products to the DCs, and hence not through the CWs, this is called direct supply. Parallel import is another external incoming flow. Parallel import occurs when companies, domestic or international, has excessive stock of a SKU and offers to sell the stock at a low price. The overstock is purchased by a company that repacks the pharmaceuticals with labels and information in the local language (in this case Swedish) and then sell it to the local market. The external outgoing flows are from the DCs to the pharmacies. All the external- and internal flows have different lead times that must be taken into account. The lead times can have affect on the inventory levels, ROP and ROQ. When the lead times are long for the products to be distributed from manufacturers to CW or DC, it is specially important to evaluate and calculate the order times- and quantities. Underestimated quantities can lead to stock-outs while overestimated quantities entail tied up capital and occupying space in the warehouse facilities.

Pharmacies have the possibility to return pharmaceuticals to the pharmaceutical distributors. The reasons for returning the pharmaceuticals can be for example excessive stock at the pharmacies or obsolete products, and hence the pharmacies do not want to have the pharmaceuticals in stock but send it back to the distributors. The pharmacies have to adapt to certain rules on which pharmaceutical and which quantity that can be returned. The rules depends on the characteristics of the pharmaceutical, example if it requires cold storage, if it is a narcotic or generical pharmaceuticals, and the reason for the return. For the generical pharmaceuticals, that are part of the SS, it is allowed to send the products back for nearly any reason. All products that are sent as returns are received at one of the DCs. There, the products are examined if they

still are valid and intact, and then either discarded or distributed back in the DC. Despite which DC the products were sent from, the entire return flow is directed to DC2. This creates inaccurate information about the outflow from each DC that is demanded from the end customers, since the products distributed from each DC are not compared to the return flows and therefore there is no accurate information about the actual demand from the pharmaceutical consumers.

The case company is currently using multiple different performance measurements on different levels in their organization. Examples of performance measurements used are service level, stock value, turnover, net working capital, picking errors, incorrectly registered orders. The measurements are used for various purposes, for example to improve the handle of products in the DCs and CWs, to streamline the distribution, and maintain a high service level.

1.3 THE PRODUCT OF THE MONTH AND THE SUBSTITUTION SYSTEM

The concepts the product of the month (PoM) and the substitution system (SS) were implemented in Sweden 2001. The concepts were an initiative by the government and the main incentive to implement it was to ensure competition between pharmaceutical manufacturers and to generate cost savings related to pharmaceuticals (TLV, 2016) The majority of countries within EU are currently using similar systems. The cost savings generated are benefiting both pharmaceutical consumers and the government. The consumers can benefit from the system since the government are subsidizing a share of the cost on the pharmaceuticals, and the government can generate cost savings since the prices on the pharmaceutical market are affected by competition and hence kept low.

When a pharmaceutical is developed and produced by a manufacturer, it is protected by a patent for a certain time. During the time the patent is valid the manufacturer have exclusive rights to produce and sell the pharmaceutical on the market. After the patent expires, any pharmaceutical manufacturer can start to produce a copy of the pharmaceutical. The original manufacturer will then start to face competition for the pharmaceutical. According to the concept of PoM, all copies that are produced together with the original pharmaceutical form a substitution group (SG). A SG contains of either one or several SKUs, the amount depends on how many manufacturers that are producing copies of the original pharmaceutical. Pharmaceuticals that are not longer protected by a patent together with the copies are called generical pharmaceuticals or generics. Generics are pharmaceuticals that are replaceable with eachothers and hence contains the same active substance and the same dosage.

The system of PoM only applies to pharmaceuticals that require prescription. However, some pharmaceuticals are available with and without prescription. In those cases the SS only applies when the pharmaceutical is sold as a prescribed pharmaceutical and not without prescription.

The SS is based on the usage of SG. All the pharmaceuticals within one SG need to be generically replaceable, contain the same active substance and have the same packaging size. Thus, all pharmaceuticals in the same SG should have the same effect for the user, and the same type of pill and the same amount of pills in the package. In each SG, the manufacturers are competing every month to make their pharmaceutical

product the PoM. Every month, a total of 5,300 SKUs are in the SS, where more than half of those pharmaceuticals are handled by the case company. The quantity of SKUs varies monthly.

TLV[1] is a governmental agency and are responsible for the PoM and SS. Once a month TLV organizes a tender where all pharmaceutical manufacturers have an opportunity to offer a price for their generical pharmaceuticals. The manufacturer that offers the lowest price for their pharmaceutical wins the tender. After the tender is completed, TLV publishes a preliminary list of all PoMs in each SG respectively. This list is public and published on TLV's webpage. Before the list becomes definite, the manufacturers have to ensure their ability to provide the pharmaceutical for the whole market during the time period. If the manufacturers can fulfill the criteria and ensure their ability to fulfill the demand, their pharmaceutical becomes PoM. If no manufacturer in a SG can ensure their ability to produce enough products to fulfill the demand on the market, no SKU become the PoM in that SG, and the pharmacies can then sell the cheapest SKU as a PoM. The tender takes place during the beginning of the month and the new PoM is valid from the first workday of the following month. TLV does not set the prices of the generics, but they are rejecting or approving the offers that the manufacturers are providing. TLV does neither make any forecasting, but they are providing historical data to the manufacturers and distributors in the supply chain.

At the tender, reserve PoMs are also decided. During the tender, the second cheapest and third cheapest SKU in each SG are also located. These SKUs becomes the first and second reserve, if the condition that these manufacturers can fulfill the demand for the whole month is confirmed. If a manufacturer producing the PoM fails to supply pharmaceuticals requested from the market during the time period, the manufacturer is required to pay a penalty fee and is no longer the manufacturer of the PoM during the rest of the time period. In this case the first reserve SKU, with the second lowest price in the SG, becomes the new PoM for the residual of the month. The same applies if the first reserve would fail to fulfill the demand on the market, then the second reserve becomes the new PoM.

When a consumer brings their prescription to a pharmacy, the pharmacy is eligible to offer the consumer the PoM even though the prescription is for a generic of the pharmaceutical. The consumer has a possibility to accept the offer, and hence benefit from the subsidized price, or decline the offer and get the original prescribed medicine. In the latter case the consumer will not benefit from price reductions, but will have to pay the original price.

[1] Tandvårds-och läkemedelsförmånsverket

Figure 1. Timeline of the PoM process for february 2017

The PoM starts to apply the first workday of the month. Starting this day, the pharmacies are eligible to offer the PoM to every consumer that has a prescription of a generic. However, it is also allowed for the pharmacies to offer this PoM as the cheapest option until the middle of the following month, which means that every PoM is valid for one month and a half, and there are two PoM valid at the first half of each month. When pharmacies are ordering the PoM they tend to order more than the expected demand in order to minimize the risk of stockouts. Having stockouts would lead to loss of sales and a decreased customer satisfaction and thus this risk is minimized by having large stocks. A timeline of the PoM process for february 2017 is illustrated in figure 1. The exact days for the PoM process varies between months and hence an example of one of the months are illustrated.

1.4 PURPOSE

The purpose of this research is to investigate how a distributor can improve their short term demand planning concerning the product of the month. In order to stay competitive on today's constantly changing global market, firms have to continuously improve their core competences to remain desirable. By performing a case study at a pharmaceutical distributor, and evaluating the currently used processes and methods related to short term demand planning and finding improvement opportunities for those, the research aims to find general improvement suggestions that are applicable in similar environments.

1.5 RESEARCH QUESTIONS

The research was performed with the base in the following three research questions:

1. What planning processes and methods related to the product of the month are currently used at the case site?
2. What improvement areas related to the planning processes and methods of product of the month can be identified?
3. How can the identified improvement areas be enhanced, in order to optimize the supply chain performance while meeting customer requirements?

1.6 SCOPE OF THE STUDY

The research has focused on the challenges that arise in short term demand planning processes in dynamic supply chains. The dynamic factor relates to the environment where the case site is operating is influenced by elements that are constantly changing.

In order to execute this research, a case study was performed. The case study was performed at a pharmaceutical distributor, with the focus on the SKUs in the SS. In this research, only the SKUs in the SS have been considered. The research has focused on the information flows to improve the handling of PoM and SS at the case site. A cost perspective has not been included during the research. The research has included an investigation of the current state at the case site, identification of potential

improvement areas, and recommendations about enhancement suggestions for these areas.

The research has included data collection, including interviews and scanning of internal documents at the case site. The interviews were performed with representatives from the case site, TLV and from a large swedish pharmaceutical enterprise.

1.7 STRUCTURE OF THE REPORT

The research comprises eight chapters. This section contains a short description of each chapter, to simplify the understanding for the reader.

• Chapter 1 includes an *Introduction* to the research. The background to the research is explained as well as why it is an important area to study. Then, a description of the case site is presented followed by a description of the PoM and SS, which are essential characteristics for this research. The chapter also includes the purpose, the research questions and the scope of the study.

• Chapter 2 comprises *Theory and Related Research*. This chapter presents the relevant theory for the research, and has the purpose to introduce the reader to the topic.

• Chapter 3 includes the *Methodology* of the research. Here, it is presented what data were collected, how it was collected, what research strategy was used, a section which described the methodology to design a framework, as well as a discussion about validity and reliability.

• Chapter 4 contains the *Results* of the research. Here, the methods and processes used at the case site are introduced, the identified improvement areas are presented, as well as the selected areas to investigate further.

• Chapter 5 comprises the *Analysis*, where the results are analyzed and discussed.

• Chapter 6 includes the *Conclusions*. Here, the findings are summarized and the research questions are reconnected to, with the basis in the previous chapters.

• Chapter 7, *Discussion*, includes a discussion about the research, if it could have been done differently, and if that would have led to a different result.

• Chapter 8, *Contributions and Recommendations*, contains the contributions of this research to general research, as well as recommendations to the case company.

2. THEORY AND RELATED RESEARCH

This section will address the theory and related research that were considered important when analyzing the case site and the processes and methods. The relevant areas for the theory and related research are related to supply chain performance, demand management, inventory control and inventory management. The role of a third party logistics provider (TPL) is as well presented in this chapter. This section aims to form a foundation which is used in the reserach analysis.

2.1 SUPPLY CHAIN PERFORMANCE

Improving supply chain performance has become one of the most important tasks for companies to gain competitive advantage. Increased product variety, shorter product lifecycles, increased outsourcing, globalization and improved information technology are factors contributing to the increased importance of improved supply chain performance and thus the need for creating a more effective suply chain (Lee, 2002; Gupta & Maranas, 2003). If a supply chain faces decreasing customer service in combination with excessive inventory, increasing costs and decreased profitability, it is a sign of a decreasing performance of the chain (Lee, 2002). Further, Lee (2002) emphasizes that in order for a supply chain's performance to be competitive, it should be adapted to the specific supply chain and it's characteristics.

Without the contribution from the firm's performance in a supply chain, the supply chain itself cannot optimize its performance. The competitive strategy for a firm should be defined by the customer requirements (Chopra & Meindl, 2013). The targets should be defined by the company's competitive strategy, that fulfills the requirements of the customers and their demand for products and sevices. In order for a firm to optimize their supply chain performance, they should understand the customer needs and the supply chain uncertainty, as well as their own supply chain capabilities. In order for a firm to have an optimal supply chain performance, the uncertainty and the capability should be made sure to fit with eachothers (Chopra & Meindl, 2013).

Demand uncertainty and forecast errors have effect on supply chain activities, this has been pinpointed in literature, for example by Fildes & Kingsman (2011). Since firms tend to spend considerable resources on forecast systems, the performance of the systems should be evaluated to ensure that they are satisfying the requirements from customers.

If the quantity of products in inventory is increased, it is more probable that customer demands will be fulfilled and therefore a high customer service level can be achieved. However, raising the safety stock also increase the tied up capital. For products with a short life cycle, for example perishable goods, this is a considerable issue since the products become obsolete if they are not sold on time (Chopra & Meindl, 2013). With the competitiveness on today's market, having shortage in stock and beeing unable to deliver and fulfill customer demand on time, can make a firm unwanted and assigned with bad reputation. Customers then tend to turn to competitors than are fulfilling the demand and can send the orders on time (Chopra & Meindl, 2013; Beutel & Minner, 2012).

2.2 THE ROLE OF A THIRD PARTY LOGISTICS PROVIDER

Third party logistics providers (TPL) are companies that are performing certain activities that other firms have chosen to outsource (van Weele, 2014). The most

common and traditional way to use outsourcing and TPL are by manufacturing firms that wants to generate cost savings, and thus they outsource some activities that can be made more effective elsewhere. However, there are other purposes than the traditional ones to use TPL. A manufacturing firm can chose to outsource some of their activities to a TPL and benefit from a strategic point of view and thus become more competitive (Skjoett-Larsen, 2000).

Traditionally, outsourcing was used by firms to generate cost savings by buying certain services from TPL companies (Gunasekaran, Patel, & Tirtiroglu, 2001). The services often included single tasks as transportation or warehousing. Often, the relationships were arms' length and no major interrelations occured between the companies. However, the area of outsourcing has developed and contemporary usage of TPL services has evolved. The relation between the firm buying the service and the TPL is today more cooperative compared to the traditional view, the services are not merely bought to reach cost savings but also to gain competitive advantages to meet customer requirements (Skjoett-Larsen, 2000).

Skjoett-Larsen (2000) presents three different forms of cooperation between a buyer and a TPL. The first one is partnership, where the buyer is maintaining the planning and management activities inhouse, while the logistics functions are assigned to the TPL. The TPL in turn provides standardized solutions that meet the customer requirements. The second form is called third party agreements, which is a more developed cooperation than the partnership. The third party agreements are based on cooperation with frequent information exchange, and a service offer from the TPL that are tailored to the buyers requirements. During this cooperation, the TPL may take over the responsibility and management of for example personnel or equipment. The third form of cooperation is called integrated service agreements, where the TPL are taking over responsibility for large parts of the logistics functions of the buyer, including management and control.

2.3 DEMAND PLANNING LEVELS

Planning is an activity made in order to support decision making in supply chains (Fleischmann, Meyr, & Wagner, 2005). Plans are made for different purposes and one related restriction is the planning level, which decides the characteristics of the planning. Fleischmann, Meyr & Wagner (2005) presents three different levels of planning:

- Long-term planning: Constitutes strategic decisions that aim to affect the firm and the supply chain on a long term, often several years.
- Mid-term planning: Planning on this level includes a time range of six months to two years. The planning is often regarding operational tasks.
- Short-term planning: The lowest level of planning. This planning level requires the most detailed and accurate information. The rage of the planning extends from few days up to three months.

For this research, only short-term planning level is relevant.

2.4 FORECAST AND DEMAND MANAGAMENT

In order to handle variety and uncertainty in demand, various methods and principles exist (Dolgui & Prodhon, 2007). The most common measure to handle uncertainty and variety in demand is through making forecasting, in order to attempt to forsee the

future demand. Beutel & Minner (2012) considers the activity of forecasting future demand as one of the largest challenges contemporary supply chains has to deal with. Literature pinpoint that various elements have affected the market and hence the activity of forecasting future demand have become more complex. A shift in the global economic climate is one reason for the changing environment on todays market, which has become more fragmented and dynamic. This are reasons that makes it more challenging for organizations to forsee future demand (Chase, 2013). Traditionally, organizations tend to focus on trend and seasonality when trying to predict demand (Axsäter, 2015; Chopra & Meindl, 2013; Chambers, Mullick, & Smith, 1971), but due to a market shift on a global level, Chase (2013) states that organizations tend to focus more on dynamic factors, such as price, promotions, sales, and other economic factors, rather than seasonality and trends, when trying to predict future demand.

The term forecasting relates to predicting future happenings. From a supply chain perspective, it refers to expecting future demand for a company's product or service. An organization can affect the future demand for their product or service to a certain extent, for example with promotions and campaigns, even though the possible effects of such activities should not be completely relied on when making a forecast (Jonsson & Mattsson, 2009). Armstrong (2001) distinguish between planning and forecasting, where planning is what something should look like, while forecasting is what something will look like. During planning processes, forecasting can be used as a tool to predict the outcome of planning.

Since some products have longer lead times than required delivery times, and the fact that products are ordered in batches due to lower ordering costs, organizations have to produce products before they are required from the market (Jonsson & Mattsson, 2009; Chase, 2013). In order for organizations to plan according to demand before the actual demand is known, forecast activities needs to be performed (Axsäter, 2015).

The forecast should include an estimation about future demand, but also uncertainties about the conducted forecast. A high degree of uncertainty entails high difficulties to forsee the future demand for the product, thus a larger safety stock is required to counterbalance for possible demand variations (Axsäter, 2015; Jonsson & Mattsson, 2009). Chase (2013), and Jonsson & Mattson (2009) claims that the demand uncertainty derives from market competition, organizations' behaviours, shorter product life cycles and a dynamic market.

Organizations should strive for using the actual demand from the market when performing forecasts, rather than data from sales (Axsäter, 2015). However, this is not always possible in practice. The actual demand from the market refers to the demand from the end customers, and thus the products and services used by the end customers. The sales refers to the total sales from an organization, including the return flow of products. If the return flow is large, sales data can be misleading (Jonsson & Mattsson, 2009). Axsäter (2015) states that demand forecasts made for inventory control purposes, usually has a short planning horizon, seldom longer than one year.

There are several different forecast techniques. However, before executing the forecast, Chopra & Meindl (2013) proposes following five steps to use as an approach when performing a demand forecast:

- Understand the objective of the forecast
- Integrate demand planning and forecasting through the whole supply chain
- Identify important measures that affects the demand forecast
- Forecast at an organization appropriate level
- Implement performance measures and errors measures for the forecast

These five steps should be used as a base when deciding the forecasting technique. Forecasting techniques can be divided into qualitative and quantitative methods (Chase, 2013; Chopra & Meindl, 2013; Chambers, Mullick, & Smith, 1971). The qualitative methods are often referred to as judgmental methods, while the quantitative methods can be classified into time series methods or casual methods (Axsäter, 2015; Chase, 2013), also called instrinsic and extrinsic methods (Jonsson & Mattsson, 2009).

Qualitative forecasting methods are using qualitative data and information about special events. In order for the data to be useful, it should be systematical, unbiased and logical, and relevant for the specific case. If enough data is available, quantitative methods are more reliable than qualitative methods (Armstrong, 2001). Qualitative methods should be used when quantitative data is scarce, then judgmental methods are used to form quantitative estimations from qualitative information. An example of when qualitative methods are frequently used is when a new product is to be launched on the market (Chopra & Meindl, 2013; Chambers, Mullick, & Smith, 1971).

Qualitative forecasting are more or less used in all types of demand forecasting. When performing a quantitative forecast, qualitative methods are usually used to adjust the forecast, with for example experience or current market conditions (Chase, 2013). Hence, forecasting methods are combinable. The method most appropriate for a certain case may be a combination of qualitative and quantitative methods. If one single method is not appropriate for the organizations and its targets, the methods can be combined (Armstrong, 2001).

The main advantages of qualitative techniques is that the methods can identify market changes faster than quantitative methods, they are also faster att interpreting and adapting to changes. Other advantages is that the judgmental methods in general are less costly to develop and by using this technique, the demand forecasts can be developed rather fast (Chase, 2013). However, qualitative methods tend to be more biased on an individual or group level, if it is not carefully determined. For example, when a group or individual executing the forecast are not related to sales, but to another department at a company, there is risk for biased forecast (Chase, 2013). The judgmental methods tend to be inappropriate for organizations handling a large number of SKUs, since the methods requires assessment of each individual SKU and hence the forecasting scope tends to become too large.

Quantitative forecast methods are usually grouped into time series methods and casual methods. In demand forecasting, time series is an important term. A time serie contains historical data about the demand for a certain period (Brockwell & Davis, 1991). The length of the period may vary, but for one forecast they should be constant. According to Chase (2013) time series methods is based on the idea that future demand can be based on the patterns of past sales. The main focus is only on historical data, i.e. on patterns and their change. When using time series as a base for

making a forecast, it is important to identify demand patterns in the data. Common demand patterns that can be identified are trends, seasonal variations, random variations, and growth rates (Jonsson & Mattsson, 2009; Axsäter, 2015; Chopra & Meindl, 2013; Chambers, Mullick, & Smith, 1971).

Major general advantages of time series methods are that they are well suited for situations where demand forecasts are needed for a large number of SKUs, they are appropriate for SKUs with unstable sales, they can even out random fluctuations; they are simple to use, to systemize and understand, they require relatively small data storage and they are suitable for short term forecasting (Chase, 2013). The drawbacks with the time series methods is that they require a large set of historical data, and large fluctuations in the current data may cause large forecast errors. They are neither appropriate for long term forecasts, since the seasonality and trend have possibility to change over long time.

Casual models uses information about relationships between the elements in a system to generate forecasts (Chopra & Meindl, 2013; Chambers, Mullick, & Smith, 1971). According to Chambers, Mullick & Smith (1971), the causal models are the most sophisticated forecast models. The basic idea of casual methods is that the future demand of an SKU is dependent on other elements from previous or current state, for example that changes in demand can be related to advertising, promotions or changes in price (Chase, 2013; Ghiani, Laporte, & Musmanno, 2013).

A causal forecast may use the information from a forecast made using time series analysis. A causal model takes consideration to all the dynamics of a system. According to Ghiani, Laporte & Musmanno (2013), the largest benefit from using causal models, is that they are adapted to forsee the possibility of variations on the variable that is forecasted. The same writers also claims that causal methods can be inappropriate to use in logistic systems, due to the difficulty to find variables that has that strong correlation with the actual case, and therefore the variables cannot be considered reliable. A summary of the advantages and drawbacks of the different forecast methods can be seen in table 1.

Table 1. Summary of advantages and drawbacks for qualitative and quantitative forecast methods

Forecast method	**Advantages**	**Drawbacks**
Qualitative	• Fast identification of market changes • Easier adaptable to changes • Less costly	• Larger risk of bias • Inappropriate for firms with large number of SKUs
Time series	• Appropriate for unstable sales • Require relatively small data storage • Appropriate for short term forecasting	• Large set of historical data required • Large fluctuations in data may cause large forecast errors
Causal	• Predict variations of forecast variable	• Difficult to find variables with strong connection

2.5 INVENTORY MANAGEMENT

Inventory control is a cruical activity for organizations to perform, in order to satisfy customer demands and to control the costs inhouse (Dolgui & Prodhon, 2007). Inappropriate inventory management and control can lead to excessive stock or stock-outs, which in turn increases the costs for an organization (Dolgui & Prodhon, 2007). An excessive stock can lead to high tied-up capital while stock-outs can lead to loss of sales. Replenishment policies contains decisions about when and how much to re-order to an inventory. There are several different policies, and they form the base for the safety- and cycle stock decisions (Chopra & Meindl, 2013). Chopra & Meindl (2013) presents two main types of replenishment policies:

- Continuous review. The inventory levels are constantly reviewed and an order for quantity Q is placed when the stock levels reaches the re-order point. The time between orders are varying while quantities are fixed.
- Periodic review. The inventory levels are reviewed at regular intervals, orders are placed at the regular reviews where the quantity is to refill the stock to reach the predetermined inventory threshold. The time between orders are fixed while quantities are varying.

This research only covers continuous review. The following subsections, 2.5.1 and 2.5.2, will describe the methods which are relevant for the research and hence used at the case site.

2.5.1 ROP

A re-order point system orders a new quantity when a certain decided inventory level is reached (Jonsson & Mattsson, 2009). The re-order point is calculated as:

$$ROP = SS + D \times L$$

Where SS is the safety stock, D is the demand per time unit and L is the lead time. The calculation will then generate a quantity of products in stock. When the inventory reaches below this level, an order should be placed to replenish the stock.

2.5.2 ROQ

Various lot-sizing methods are mentioned in literature. Usually, the lot-sizing methods are characterized as fixed or variable methods (Jonsson & Mattsson, 2009). Economic order quantity (EOQ) is considered to be the most simple fixed method (Dolgui & Prodhon, 2007). Jonsson & Mattsson (2009, s. 446) states that the EOQ is ”*a type of fixed order quantity model that determines the amount of an item to be purchased or manufactured at one time. The intent is to minimize the costs of acquiring and carrying inventory*”. The quantity calculated is fixed while the time between the orders may vary. The method used to calculate the EOQ is the Wilson formula. The EOQ formula is based on following assumptions (Arnold, Chapman, & Clive, 2014):

- Demand is known and constant
- The SKUs are purchased in batches
- The holding- and ordering costs are known and constant
- Replacements are occuring immediately

The EOQ is calculated as:

$$EOQ = \sqrt{\frac{2 \times D \times S}{I \times C}}$$

where D is the demand per period, S is the ordering cost per order, I is the invenroty carrying cost per period, and C is the value of the item. The calculation will generate a value for EOQ, which represents the most economical optimal quantity to order from the perspective of the mentioned elements (Jonsson & Mattsson, 2009).

2.5.3 SERVICE LEVEL

Axsäter (2015) and Chopra & Meindl (2013) presents following three service level definitions, that are most common the use at a firm:

- Probability of no stock out per order cycle
- Fill rate, i.e. how big share of demand can be fulfilled immediately from stock on hand
- Ready rate, i.e. positive stock on hand (no stock outs)

Other methods to measure the service level are presented in literature. In order for an organization to choose and adapt to a service level definition, the definition should be understood and adapted in the same way throughout the whole company. If it is possible to follow up the real percieved customer service and compare it to the definition and the target, that is an advantage. However, this is usually not possible since the follow up most likely would be resource- and time consuming (Axsäter, 2015).

In general, it requires great resources to have the same service level for every product at a firm. Therefore, it is beneficial to adapt the service level to each product, depending on if the product is considered as important or not at the company, based on certain criteria. Yet, it is in practice difficult to assign each single product an individual service level. One solution to overcome this problem is to group the products that is adapted for the company and its' products, and then assign a certain service level for each group (Axsäter, 2015). One way of grouping the products is through conducting an ABC-analysis.

2.5.4 SAFETY STOCK

To ensure product availability, an organization can introduce safety capacity in production, such as safety stocks or buffers (Dolgui & Prodhon, 2007). When actual demand exceeds the forecasted demand for a period, safety stocks are held to be able to still supply the market. Safety stocks are needed due to uncertainties in demand and to be able to ensure supply to customers, variance in demand during lead time, length and variability of lead time, frequency of orders and desired customer service level and since products usually are manufactures and delivered in batches (Whybark & Williams, 1976; Jonsson & Mattsson, 2009)

Chopra & Meindl (2013) emphasizes two factors that determines the appropriate level of a safety stock: the uncertainty of demand and supply, and the desired level of product availability. The more uncertain the demand and supply is, the higher level of safety stock is required. Dolgui & Prodhon (2007) states that a safety stock has the

objective to minimize both shortage and holding costs while meeting a target service level.

2.6 ABC-ANALYSIS

An ABC-analysis includes categorizing things, such as the SKU's at an organization. The aim of the analysis is to distinguish which SKU's that are considered more important according to certain criteria and hence which SKUs should be prioritized (Liu, Liao, Zhao, & Yang, 2016). The principles of the ABC analysis is based on Paretos principle, also called 80-20 rule which means that 80 percent of results is derived from 20 percent of the effort (Flores & Whybark, 1987; Lung Ng, 2007; Mattsson, 2003; Chen, Li, & Liu, 2008).

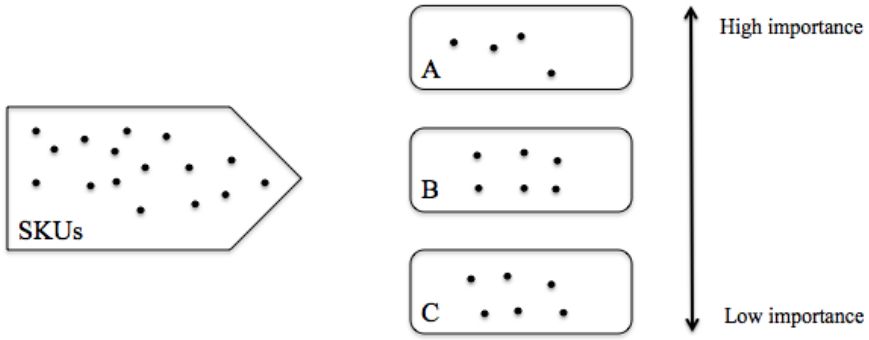

Figure 2. Illustration of an ABC-analysis. Based on Chen, Li & Liu (2008)

The principle used when performing an ABC-analysis is showed in figure 2. A firm has a number of SKUs which after the conducted ABC-analysis are placed in one of the categories A, B or C. SKUs places in category A are considered as important, also called *the significant few*, which traditionally are SKUs with high value but small in quantity. Category C contains SKUs which are considered less important, *the trivial many*, while category B represents the SKUs in between (Flores & Whybark, 1987; Chen, Li, & Liu, 2008; Liu, Liao, Zhao, & Yang, 2016).

Allocating the SKUs to the categories A, B and C can be done using various criteria. The traditional ABC-analysis is performed using one single criterion. The most mentioned criteria in literature are cost-related, such as the annual dollar usage (Chen, Li, & Liu, 2008; Flores & Whybark, 1987; Flores, Olson, & Dorai, 1992; Mattsson, 2003) and it appears that that is often the only criterion used when categorizing SKUs. According to Liu, Liao & Zhao (2016), the only appropriate case to use an ABC-analysis with a single criterion, is when the SKUs are rather homogenous and the main difference is the annual dollar usage. The authors argue that the traditional classification method, using only a single criterion, often is counterproductive when performing the ABC analysis. Flores, Olson & Dorai (1992) supports the argument that there can be drawbacks with using one single criterion and in most cases it is inappopriate when conducting an ABC-analysis. Executing the analysis with one criterion are underlining the importance of SKUs with high annual cost, even though they are not important from other perspectives. At the same time, SKUs with low annual cost and high importance for the firm gets under-emphasized. Several authors are commenting the inappropriate use of a one criterion-method and are instead

purposing a multicriteria method (Flores, Olson, & Dorai, 1992; Flores & Whybark, 1987).

By using multiple criteria including non cost related ones, a more equitable categorization can be done. Flores & Whybark (1987), Chen, Li & Liu (2008) and Liu, Liao & Zhao (2016), proposes following criteria as alternatives when performing a multicriteria evaluation: lead time, part criticality, availability, substitutability, repairability, obsoloscence, durability, inventory cost and commonanlity.

Mentioned criteria can be used to perform a multicriteria ABC-analysis. Depending on the type and nature of the organization conducting the analysis, the characteristics of its' SKUs and the purpose of the ABC-analysis, which criteria considered important and how many different criteria to use for the specific analysis, will vary. When an organization performs a multicriteria ABC-analysis, some method must be used when classifying, ranking and analyzing the different criteria used (Flores, Olson, & Dorai, 1992). Flores & Whybark (1987) purposes the use of a matrix when using two criteria for classification, which is illustrated in figure 3. The matrix uses presents two different criteria: criticality and annual dollar usage. The squares marked with X, represents the criterias where both the categories has been given the same rating, so-called AA, BB, CC, and the other squares are marked with dots.

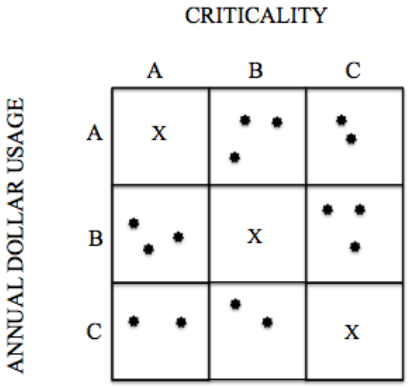

Figure 3. Two criteria matrix. Based on Flores, Olson & Dorai (1992)

According to Boylan, Syntetos & Karakostas (2008), the field of demand categorizing have recieved limited academic research. There is a high amount of research focusing on forecast methods and classification of inventory, but there is limited research about how different demand patterns are influencing those. Boylan, Syntetos & Karakostas (2008) presents a division that can be done to categorize SKUs based on their demand patterns:

- Intermittent demand: the demand of an item is occuring infrequently
- Erratic demand: the demand size of the item is highly variable
- Slow moving demand: the average demand of the item is low, due to infrequent demand occurances and/or low average demand
- Clumped demand: the demand is intermittent, but constant when it occurs
- Lumpy demand: the demand is intermittent and highly variable when it occurs

According to the authors, depending on the demand patterns of the SKU, it should be managed differently regarding for example choice of forecast method.

When deciding an appropriate safety stock, the service level is often used as a base (Mattsson, 2003). Keeping stock entails costs, such as tied up capital and stock holding costs, therefore the stock level has to be evaluated and only the most cruical SKUs should have a large safety stock (Whybark & Williams, 1976). To use an ABC-analysis as a base to decide what service level each SKU should have, and thus how large safety stock each SKU should have, is efficient since the most important SKUs then will be prioritized. Criteria to use when deciding if an SKU is important or not is often cost related, though variation in demand is also an important criterion, since a larger variation in demand requires a larger safety stock to minimize the risk of having stock outs. To decide the variation in demand, MAD can be used as a measure, which is a functionality in many enterprise resource planning-systems (ERP-systems) (Mattsson, 2003).

3. METHODOLOGY

This chapter describes the chosen research strategy, which is a mixed method with both a qualitative- and quantitative approach. Further, the chapter describes the approach of finding theory and related research, followed by how the data in the research was collected and analyzed. After this a section follows where it is described how to develop a framework, and the chapter is finalized with a discussion about the validity and reliability of the research.

The research was performed in collaboration with a student from Luleå Technical University. The project was conducted jointly at the case site, while each student wrote a report for their university respectively. The reports have fairly different focus, the student from Luleå Technical University had a focus on analyzing the case site's assumptions about trend and seasonality, as well as forecasts and forecast errors. This report has focused on identifying the elements that contributes to the difficulty of handling the product of the month, as well as proposing improvement suggestions for some of the areas.

3.1 RESEARCH STRATEGY

The conducted research was performed using mixed-method research (Yin, 2014), where qualitative and quantitative research methods have been used in a case study. By using a mixed-methods research strategy, more complicated research questions can be examined and a broader spectrum of data can be collected, compared to using a single-method research approach. It is essential to define the current state of an organization before an enhancement foundation can be established.

The research had a case study approach, with a third party logistic provider company as case site. According to Yin (2014) the definition of case study is twofolded. The first part of the definition is related to the scope of the study. Yin (2014, s. 16) states that ”a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident”. The second part of the twofolded definition relates to the features of the case study. The second part, Yin (2014, s. 17) defines as ”a cast study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis”.

The research strategy for the case study is shown in figure 4. The case study was performed in an exploratory manner, i.e. to identify research questions to be used in a research study (Yin, 2014). The case study was initiated by creating a definition of the current state at the research site, which is a pharmaceutical distributing company. The definition of the current state at the organization was conducted mainly using conversational interviews, observations and by collecting and reviewing relevant data. At the second stage, the current problems at the research site linked to the research focus was identified and interrelated. This was conducted mainly using semi-structured interviews, analyzing relevant data and benchmarking different methods to the ones currently used at the research site. Lastly, improvement suggestions were developed. The main focus during this stage was to test the arbitrary assumptions

using historical data, to evaluate the forecast methods and to develop a tool for enhanced performance of the manual tasks.

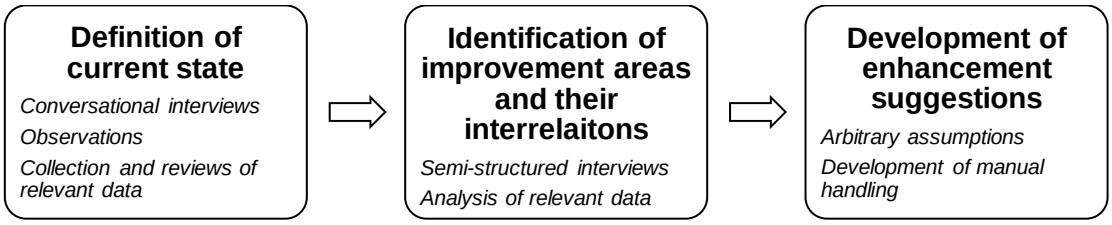

Figure 4. Research strategy for the case study

The research used quantitative and qualitative approaches to evaluate the current organization, its methods and processes, and to explore the future possibilites. Qualitative research uses words when collecting data while quantitative research uses quantification when collecting numerical data and views theory and research as a deductive relationship (Bryman & Bell, 2015). A deductive relationship refers to hypotheses deducted from theory and thereon the research is based on those.

The quantitative approach aimed to collect and analyze data from for example sales, internal deliveries, return flows, forecast and forecast accuracy. This was done in order to distinguish which data to use when performing the analyse of focal areas. The qualitative approach aimed to gather information about the case site, mainly about its processes and methods. The qualitative approach was mainly conducted using interviews, both conversational and semi-structured, to collect information from so called experts within relevant areas.

3.2 APPROACH TO SELECT THEORY AND RELATED RESEARCH

The aim of the literature search, which findings are called *theory and related research* in this report, was to establish a theoretical foundation of important concepts for the research, as well as examining relevant contemporary research to understand what has been done in the focal area so far. To get a complete understanding of the areas presented in *theory and related research*, it has been evaluated what is novelty in the research. After conducting a comprehensive literature review, gaps in the research was identified.

In order to select relevant literature, a vast amount of literature was read and analyzed to determine if it was relevant for the research or not. Relevant literature was found using several data bases, such as Chalmers library, Google scholar and Scopus. Key-term used for literature search were ”forecast”, ”supply chain performance”, ”demand management”, ”inventory control” and ”ABC analysis”.

The case site consists of a distributor with the core competence within logistics, where the focus of this research is on the internal handling of the PoM. The main literature found related to the key-terms were connected to manufacturing, which is not considered to be relevant in this research, since the case site does not conduct any manufacturing. However, the literature has been evalated if it is applicable for the environment of the case site, despite the different main focus. The applicability was evaluated in such a way that the arguments and facts presented in literature was

benchmarked with the case site, if similar characteristics could be found in the case site the arguments are applicable as well.

3.3 DATA COLLECTION

According to Yin (2014), there are six sources of evidence when performing case study research; documentations, interviews, direct- and participant observations, archival records and physical artifacts. In this research, all but physical artifacts have been used as sources of evidence. Multiple sources of evidence were used to collect a broad scope of relevant data.

During the research, documentations included several administrative documents, such as progress reports and several other internal documents, evaluations related to the focal area. Regarding the interviews, conversational interviews were held initially at the case site to get an overview of the organization, their methods and processes, their customers, and to identify key persons. The participants in the conversational interviews are listed in table 2. During the conversational interviews, the participants were initially asked to tell and show how they performed their work related to PoM, and what were their personal findings and thoughts about PoM and the problems related to it. All the conversational interviews had various lengths and outcomes, and as an addition to the initially asked questions, new questions and discussions arose during the interviews. The key persons in this context were persons with expertise within any focal area related to this research.

Table 2. Participants in conversational interviews

Role	**No. of participants**	**Organization**
Purchaser	5	Case company DC1
Head of logistics	1	Case company DC1
Material Handler	1	Case company DC1
Group manager	1	Case company DC1
Business Intelligence	2	Case company DC1
Process Coordinator	1	Case company DC1
Manager	1	Case company DC1

Semistructured interviews were conducted with the identified key-persons, where each interview contained questions related to the key persons area of expertise. The participants in the semi-structured interviews are listed in table 3. The questions used at the semi-structured interviews are listed in appendix 1. As a complement, observations were conducted to identify how different methods and tools are used internally. Semistructured interviews were also held with experts outside the case site. The experts were representatives from TLV, a pharmaceutical enterprise and the case company DC2. The pharmaceutical enterprise is one of the largest ones in Sweden. The case site is cooperating with this enterprise, therefore they were considered important to get a full view of the supply chain. The external experts were in general considered to be important for the research, since they are key stakeholders in the supply chain of the case company.

Table 3. Participants in semi-structured interviews

Role	No. of participants	Organization
Purchaser	2	Case company DC1
Head of logistics	1	Case company DC1
Business Intelligence	1	Case company DC1
Process coordinator	1	Case company DC1
Representatives	3	TLV
Representatives	3	Pharmaceutical enterprise
Branch manager	1	Case company DC2

Both participant observations and direct observations were made at the case site in processes where the PoM was handled. The direct observations included observations of the handling of SKUs in the CW and DC, for example how the flow is constructed for SKUs through the whole organization, since these activities were assumed to increase the understanding of the case site and the related problems. The participant observations included observing several employees performing their normal tasks, and participating with questions to increase the understanding. These observations included for example sessions where internally developed programs were demonstrated and explained, and how they related to the handling of the PoM.

The archival records used in this research refer to data from the ERP-system, from the extrenal program, IMS data and data from TLV. The data from the ERP-system used was historical sales, stock levels at the different DCs, order lines and internal movement of goods. The program that is referred to as the external program, is handling some of the PoM forecasting and inventory control, from this program data was collected about for instance historical sales and inventory levels. IMS data is the data which the case company purchases from an external company. The data contains sales from pharmacies on an aggregated national level, and includes the sales of all the SKUs from pharmacies. Since it is only possible for the company to obtain a limited amount of information about the SKUs on the market, i.e. only the SKUs they are handling themselves, the IMS data provides a guideline on how large to total demand is from the market. Data from TLV included the documents with the information about for example which SKU is the PoM and the reserves and the SKUs that are part of each SG.

3.4 DATA ANALYSIS APPROACH

The approach used when analyzing the data was iterative, where the literature review and the empirical findings were constantly updated and linked. The structure of how the data was analyzed is conceptualized in figure 5.

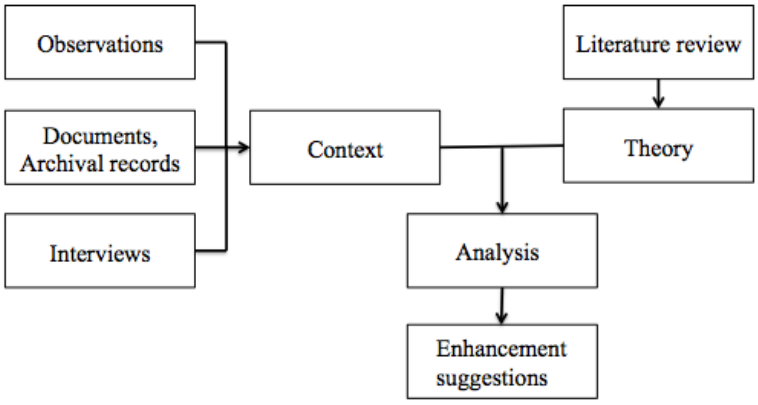

Figure 5. Data analysis approach for the research

The collected data from observations, interviews, documents and archival records, were analyzed and put into its context. By conducting a literature review, a theoretical frame was established, which then could be used to interpret the context. By analyzing the theoretical frame and the context, problems were identified at the case site. With the base in the established context and theoretical frame, enhancement suggestions were made.

3.5 METHODOLOGY TO DESIGN A FRAMEWORK

The case site's organization operates in a dynamic environment where both external and internal factors affect the site. External factors refers to that they are not possible to affect, while the internal factors can be affected. Due to the dynamic environment, the most suitable solution was to develop a method that is possible to apply despite the environment. The tool developed in this research used a method that is described in this section. With the aim to enhance the methods that are used for the PoM today and to decrease the risk of having excessive stock at the DCs, the largest possible enhancement that can be done is to design and propose a method that can be used in the dynamic environment.

The purpose to develop the framework is to enhance the planning process at the company, to minimize the risk of having excessive stock, though simultaneously eliminate the risk of having stock-outs and thus not be able to fulfill customer orders. There is larger risk and cost related to having stock-outs compared to having an excessive stock, therefore the levels of cycle stock or safety stock should not be compromised with having too low stock levels.

The seven steps to develop a framework are presented in figure 6. The framework, suggested by Philibert (2016), contains research, analysis and concepting, testing, refining, selling, building, and using and adapting.

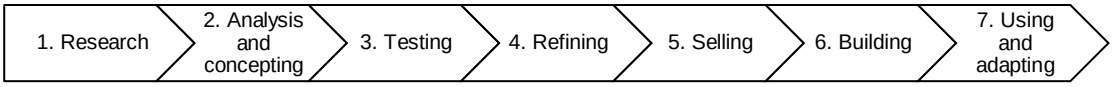

Figure 6. Seven steps to develop a framework. Based on Philibert (2016)

According to Philibert (2016), step one includes performing the research, which is required to design the framework. This includes gaining information, assets and data from the case site and the area of interest. It should also include the external influences that will affect the framework. The second step encompasses a review of the problem from several perspectives while continuously adapting a critical mindset. Step three includes testing the framework in order to find shortcomings and areas of improvements. The fourth step contains using the information gathered in step three, in order to improve the process so far and adapt to new data. The fifth step includes communicating the benefits of the framework to the users and make sure that they understand the advantages with using it.

Steps six and seven are assigned to the case company, since they possess the experience and knowledge of what works internally. Step six includes designing the software that is required to use the framework. This may include creating a program. Step seven involves keeping the framework up-to-date and continously adapting to support the needs in future. It may also include giving support for the users and developing new functions. Though, this research will only focus on development of a tool by using steps one to five, and hence step six and seven will be excluded.

The research, step 1, in this project was performed during a period of two months. During this period, knowledge about the case site was gathered and an understanding about its' processes, challenges and interrelations was collected. With basis in this knowledge, semi-structured interviews were performed with experts within relevant areas.

Traditionally when performing ABC-analyses, cost-related criteria such as annual dollar usage, are considered as the most important criteria (Flores & Whybark, 1987). Though, in this research the cost perspective is not considered as important since the focus is on the main problem, which includes lack of floor-space at the DCs. The basis in the framework developed is using ABC-analysis and making the division according to the Pateros principle.

The dynamic environment entails a certain unavoidable amount of manual work. The aim with implementing this framework is to decrease the extent of manual tasks, though they are currently inevitable to avoid completely.

3.6 VALIDITY AND RELIABILITY

The reliability and validity was constantly considered during the research. This section includes the definition of validity and reliability as well as a discussion about how well the different definitions were met during this research. Bryman & Bell (2015) states that reliability concerns if the result of a study is repeatable, i.e. if it can be applied to other similar environments. Reliability is in particular an issue when performing quantitative research, due to the difficulty to assess if a measure is suitable or not for a specific research.

When considering if a measure is reliable, three important factors can be used:

- Stability, which assesses the stability of the measure over time
- Internal reliability, which is measuring if the indicators that makes up for the findings are consistent
- Inter-rater reliability, which covers the lack of consistency in decisions, for example if more than one assessor is part of categorizing data, or translating observations

In this research, the stability of the findings are considered low. Since the research is performed in an environment, which is identified as vastly dynamic, stability over time is rather difficult to assure. The research and its findings have had a focus on the measures that are stable over time, however these kinds of measures are not consistently stable over time. Therefore, this research is adaptable to the current situation and the environment of the case site. The internal reliability is considered as stable, since the findings of the research have focused on non-dynamic indicators. Even though the environment is constantly changing, the indicators used as a base for this research can be replaced and therefore applicable despite a dynamic environment.

Considering the inter-rater reliability, even though the research was made in collaboration with another student, considerable interpretation of data has been made individually and therefore the content in this report is considered to have a high inter-rater reliability. During the research, an aim towards a non-biased approach has been kept, and thus the research can be seen as non-biased. However, at all times there is a probability that bias may have affected the outcome.

Validity relates to the integrity of the conclusions that derives from a research (Bryman & Bell, 2015). Several types of validity can be distinguished:

- Measurement validity – is the chosen measurement appropriate with what that is to be measured?
- Internal validity – is the conclusion of the findings credible?
- External validity – can the study be generalized beyond the specific research context?
- Ecological validity – is the findings applicable with humans natural social settings?

The various aspects of validity have been included in the research. Considering the measurement validity, other measures could have been as good as or even better than the chosen ones. However, in the research various measures have been evaluated and tested, and the chosen ones were the most appropriate ones found. The internal validity is considered to be consistent and the findings of the research have been constantly iteratively discussed with representatives from the case company, the other student and the supervisors. Relating to previous research and theory as well as the current state at the case site, the findings and the conclusions are considered as credible. To a certain extent, the research can be generalized beyond the specific research context. If so, it has to fulfill some certain requirements to be applicable. Though, some general findings from this research are applicable in environments that are not the same as the case site. Finally, the perspective of ecological validity has as well been considered. Though, since the findings are mostly focusing on strategies rather than operative tasks, this perspective of validity has not been in focus.

4. RESULTS

This chapter presents the results of the research, and is related to the research questions presented in chapter 1. This chapter includes the methods and processes currently used at the case site as well as the identified improvement areas, which include elements that are possible to influence and elements not possible to influence. As well, the chapter presents the improvement areas that were further investigated, as well as the result that was achieved in these areas. The improvement areas that were further investigated refer to examination of two currently used assumptions at the case site as well as improvement of the current manual handling.

4.1 DEMAND PLANNING METHODS AND PROCESSES RELATED TO PRODUCT OF THE MONTH USED AT THE CASE SITE

Only short term forecasting and demand planning is done for the generics at the case site. A tender is held monthly and any manufacturer within the SG can win each time and become the PoM, hence there is no purpose to perform any forecasting longer than one month, since the demand is highly likely to change on a monthly basis both regarding SKU and quantity. Every manufacturer have their own strategy to make bids at the tender with the lowest price and thus become PoM. The strategies are related to for example the manufacturers' production planning. However, the information about the strategies at the manufacturers is not shared with the pharmaceutical distributors. The only source of information that the case site has about the future PoM is TLV, who presents the PoM once it is chosen.

The case site uses multiple systems to handle demand planning and forecasting of their SKUs. The systems used is an ERP-system and an external program. In order to distinguish which method to use, a certain system is used where the SKUs are given codes. The codes are controlling which systems that is used when calculating the forecast and the inventory levels for each SKU. Depending on the code the SKUs have, the forecast and the target inventory levels is calculated either through the case site's ERP-system, or through an external program. The external program was developed to complement the ERP-system in cases when there was lack of historical data. The ERP-system has a requirement of a certain quantity of historical data to execute the calculations, and therefore it can not be used for all the SKUs. Due to the dynamic supply chain, that the demand of an SKU is constantly varying to a high extent, and therefore data from when an SKU was not PoM cannot be used when forecasting the same SKU when it is PoM.

The code given to each SKU depends on what characteristics the SKU has. For some SKUs, the ROP and ROQ are fixed and therefore not recalculated every month. This can be due to for example requirements from the pharmaceutical manufacturers. For the majority of the SKUs in the SS, the forecast and inventory levels are recalculated every month since the demand varies depending on which SKU is chosen as the PoM. For this majority of SKUs, the codes are decided based on how many months in row a SKU has been PoM, or how many months in row it has not been PoM.

For SKUs that are lacking three months of consistent data, such as SKUs that have been PoM for less than three months in row, the forecast and the ROP and ROQ are calculated through the external program. The external program is using the time series method moving average when forecasting. The external program uses two months historical data to calculate the forecast, ROP and ROQ. The data used is IMS-data,

which includes monthly sales from pharmacies to end customers on an aggregated national level.

For SKUs that are PoM the second or the third month in row, the same information is used as when the SKU was PoM the first month and the inventory levels and forecast was calculated thorugh the external program. Hence, it is assumed that the SKU will have the same monthly demand when it continues to be PoM. The SKUs that are PoM are assumed to represent a certain percentage of the demand in the SG. If the SKU has consistently not been PoM for two or three months, the same information is used as when the SKU was not the PoM the first month since it is assumed that the SKU will have the same demand when it is no longer PoM. The SKUs that are no longer the PoM are assumed to represent a certain fixed percentage of the demand in the SG.

For the SKUs that continues to be PoM after three months, there is available historical data on how the actual demand has been for this SKU. Therefore, the ERP-system can be used to forecast the future demans, and calculate the ROP and ROQ, for the SKU using historical data. The ERP-system requires a set of at least three months consistent historical data in order to calculate inventory levels and generate forecasts, therefore only the SKUs that fulfill this can be calculated in the ERP-system.

Since the demand varies highly for a SKU between months depending on if it is PoM or not, the forecast of an SKU that is PoM should not be based on historical data from when the SKU was not PoM, and vice versa. This will lead to errors in the forecast. Depending on how much the demand varies for an SKU when it is PoM, and not PoM, the forecast errors will vary.

4.1.1 THE EXTERNAL PROGRAM

The external program is a tool developed in Excel. It was developed internally at the case site and it applies for SKUs that does not have three months consistent data, for example when a SKU is the first month PoM. The program uses sales data on an aggregated national level that is purchased from an external company. This data includes sales from pharmacies to end consumers on a monthly aggregated level. The external program is calculating the ROP by multiplying the daily forecast with the lead time and adding a safety stock. The lead time is expressed as the physical lead time and the administrative lead time.

The daily forecast derives from the monthly forecast by dividing the forecasted monthly demand with the number of days in the month. Hence, it is assumed that there is no seasonality within one month but the demand is assumed to be constant. As mentioned before, the external program uses moving average as forecast method. To create the monthly forecast it is taken into consideration which DC the units are demanded from. It is assumed that units distributed from DC1 accounts around 35 percent of the total sales, from DC2 around 55 percent of the total sales, and from DC3 about 10 percent of the total sales. In order to generate a forecast, the time series method moving average is used by calculating the average sales of a SG from the two previous months. The average is then multiplied with the factor of which DC the units are sent from, and then multiplied with the assumed share that the PoM is consituting from the whole SG. This assumption is fixed for all SG, and it is assumed that a PoM will constitute 80 percent of the total sales in one SG at all times. Thus, the forecast is made for the whole SG and the PoM is assumed to constitute 80 percent of the total forecast.

The safety stock is based on the SKUs number of days-in-stock, which is decided at the case site based on experience. Depending on the number of days-in-stock, the safety stock will be calculated using one of two different methods. Though, both of the ways includes the daily forecast multiplied with a certain parameter. Axsäter (2015) writes that a targeted service level requires an accordingly set parameter. Hence, the company has a targeted service level and choose the corresponding parameter to multiply with the daily forecast. The re-order quanity (ROQ) is calculated using the Wilson formula. The ROQ is only considered valid if it is larger than the weekly demand, and lower than the monthly adjusted demand, i.e. the monthly demand multiplied with a parameter. This parameter is decided by experienced personnel.

4.1.2 ERP-SYSTEM

The ERP-system uses internal sales data when making forecasts, which represents the sales from the case site to the pharmacies and is received from the ERP-system itself. The system requires a consistency of 3 months sales data, i.e. the SKU is required to have been PoM during three months or not PoM during three months continuously, in order for the ERP-system to be able to create a forecast from the historical data. The ERP-system is generating a forecast for a specific SKU, based on the historical sales from the specific SKU, and also takes into account from which DC it is ordered. Hence, in the ERP-system assumptions about the distribution of demand or the proportion of PoM demand in a SG is not required.

The forecasts made in the ERP-system are based on the time series forecast methods moving average (MA) and weighted moving average (WMA). The system is calculating a forecast once with MA and once with WMA, and the mean absolute deviation (MAD) is calculated, i.e. the deviation between the forecast and the actual value, in order to find the best fitting model. This is done for each SKU, and the generated forecast that has the lowest MAD is chosen for this particular SKU. MAD is calculated regardless if the SKU is PoM or not, which means that is a product was PoM a long time ago, the MAD is not reasonable since the demand varies greatly. If an SKU is PoM one month but not the following, the calculated MAD will be too high and therefore not fair, and vice versa.

In the ERP-system, the daily forecast is calculated as the monthly forecast divided by the number of workdays in the month, which is similar as in the external program. Hence, the assumption that the demand is constant from day to day is as well made in the ERP-system. As well, the annual forecast is the monthly forecast multiplied by 12, and hence the assumption is that there is no seasonality between months.

The safety stocks are calculated using two methods that vary slightly. The method that generates the highest level of safety stock for each SKU is chosen in order to minimize the risk of stockouts. The ROP is calculated using the same method as in the external program, where the daily forecast is multiplied with the lead time, and then added with the safety stock. The ROQ is calculated using the Wilson formula here as well, and minimum and maximum levels of ROQ are issued to make sure the level does not get too high or low.

The case site is using life cycle codes to classify their products. This classification is done to simplify the handling of SKUs in various life-cycle states. Novelty products may have an uncertain demand- and growth pattern, since they are newly introduced

on the market, while products that have been on the market for a long time are getting obsolete and should not be assumed to last long on the market.

In order to get notification about low or unusual stock levels, various alarm lists are used to notify if this occurs. The lists are generated several times per day and they include SKUs which have too low stock levels compared to the demand and the next incoming delivery. When an SKU is alarmed to have too low amount of units in stock, the purchaser will contact the DC and CW to verify the correctness of the alarm. If true, the manufacturers are contacted and the next incoming order can be advanced or changed to a larger quantity.

4.2 IDENTIFIED IMPROVEMENT AREAS AT THE CASE SITE

The identified improvement areas at the case site and their interrelations are illustrated in figure 7. The identified root cause for the risk of excessive stock in the DCs is the demand uncertainties from the market. Since the PoM cycle is one month, and a new PoM is introduced in the beginning of each cycle, the demand of different SKUs from the case site can vary significantly. In some PoM cycles, the case site is handling a considerable number of SKUs that are PoM, while during other cycles they can have a significantly lower amount. During months when the case site is handling fewer SKUs, the competitors are handling more. The same applies to the reserve PoMs, since the demand of SKUs is varying greatly from month to month. This demand uncertainty that the company is facing is identified as a root cause for the risk of excessive stock in the DCs.

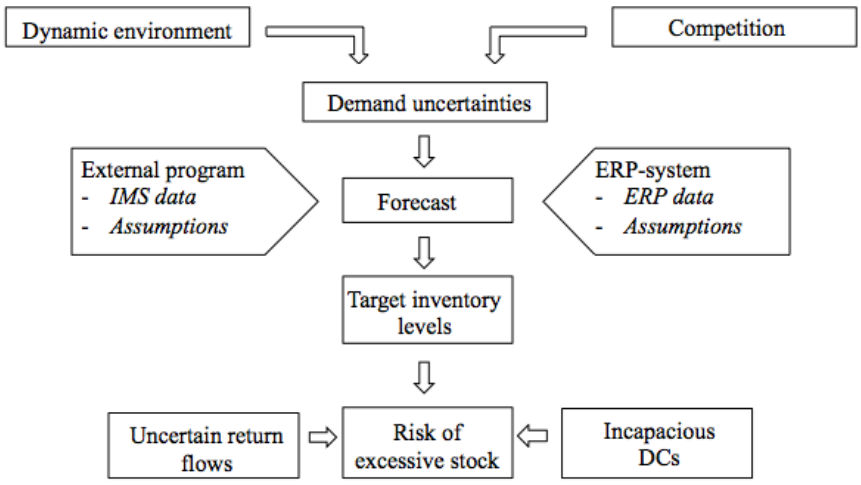

Figure 7. Identified improvement areas at the case site

The identified reasons for the demand uncertainty is the dynamic environment, which the case site is acting in, and the presence of competitors on the market. As already stated, the presence of competitors creates gaps of information about the demand from the market and the levels of SKUs in competitors' stocks. The identified reason for the dynamic market derives from the supply chain where the case company is acting, which can be seen as rather complex. The dynamic environment where they are acting handles pharmaceuticals, which entails rules and legislation, complete visibility and traceability through the supply chain and requirements of high control. The identified main reasons for the dynamic environment are:

- New SKUs are continuously introduced on the market
- New SGs are formed and eliminated
- Obsolete SKUs are eliminated
- Patents on pharmaceuticals expires and copies are produced by competitors
- The number of SKUs in each SG is constantly changing
- Pharmaceutical manufacturers change which pharmaceutical distributor to cooperate with
- Every month a new PoM is presented
- External factors, for example weather and season.

Due to demand uncertainties, forecasts are made in order to foresee future demands without having any actual information about it. When making the forecasts, multiple systems are currently used. One system used is the organizations ERP-system, where the sales data to pharmacies are used as well as multiple assumptions. These assumptions includes that the demand has no seasonality between or within months as well as no trend.

The external program, developed internally at the case site, is using sales data purchased from an external company, which includes the sales from pharmacies to the end customers. The external program are using multiple arbitrary assumptions as well, such as that 35 percent of the total sales are demanded from the area near DC1 and therefore distributed from the DC1, 55 percent of the total sales are demanded in the DC2 area, and 10 percent of the total sales are demanded and distributed from DC3. Another assumption is that the sales of the PoM constitutes 80 percent of the total sales in a SG, and the SKU that was PoM the previous month will constitute 12 percent of the total sales in a SG the following month. The external program also uses the assumption of no trend and no seasonality within or between months when creating the forecast.

The arbitrary assumptions currently used are merely based on intuition and experience. The interviews with representatives from the case site, gave information that the assumptions have never been based on any actual historical data nor have they been evaluated about their performance. The assumptions were implemented several years ago and the case site believe that they have worked sufficient enough. The assumptions have never been updated according to current market situation, or verified with historical data.

In addition to the multiple programs used, a large amount of manual work is required. Some of the manual work is even initiated due to that multiple systems are used. Due to last minute changes, for example requirements from manufacturers or from pharmacies, purchasers at the case site often make manual adjustments to inventory levels, i.e. how large quantities that should be moved from CW to DC. Currently, there is no standardized way how to make the manual adjustments, but instead they are currently evaluated in each case depending on the characteristics of the adjustment, the available resources and the importance of it.

The generated forecast is used when calculating the target inventory levels, ROP, ROQ and safety stock. The description of how these are calculated is presented in section 4.3.

The return flow of the PoM is highly fluctuating. There are several rules that the pharmacies have to follow when returning SKUs that are PoM. However, today the whole return flow is directed to DC2, despite from where is was originally dispatched to the pharmacy. Pharmacies are ordering pharmaceuticals, not only what they forecast to be demanded from customers, but also to create a safety stock of their own. This leads to that the SKUs distributed from DC1 and DC3 do not constitute the actual demand from the end customers, but includes the actual demand from the end customers plus the return flow and the pharmacies safety stock. The amount received at DC2 is thus the whole return flow. Since the size of the return flow is uncertain, non of the DCs can consider the return flow when distributing. This was of arranging the return flow leads to a higher risk of excessive stock at DC2.

The case site at DC2 face limited space in the inventory. It is desirable to expand the facilities, though this is not possible due to surrounding facilities. Since there is currently no possibility to expand the DCs, the amount of SKUs withdrawn from the CW to DC has to be more controlled.

All these factors have been identified to contribute to the possibility of excessive stock at the DCs.

4.3 INVESTIGATED AREAS OF IMPROVEMENT

This chapter includes the investigated areas of improvement. With the base in the identified improvement areas in the previous section, certain areas were chosen to investigate further. The chosen areas were the currently used assumptions about distribution of demand and the demand of PoM, as well as the non-standardized manual handling. The chosen areas were selected due to data availability and competence areas at the case site.

4.3.1 ASSUMPTION: DISTRIBUTION OF DEMAND

The assumption made at the case site that around 55 percent of the products are distributed from DC2 to customers, around 35 percent from DC1 and around 10 percent from DC3 was analyzed using sales data. This assumption is made not only for SKUs in the SS but also for all SKUs at the case site, both pharmaceuticals and non-medical products. The assumption was analyzed since the current assumption is mainly based on experience and fair estimations, rather than on actual historical data.

The share of products distributed from each DC to the end customers, is affecting the calculations of the ROP and ROQ, both in the external program and in the ERP-system. The formulas used to calculate ROP and ROQ are presented in section 4.3. In turn, the values of ROP and ROQ are influencing the stock levels in the DCs.

The datasets used to examine this covers 14 months[2]. The data of interest from these was the number of units sent out from each DC to customers. Note that this analysis was made for all the products handled at the company, both PoM and SKUs outside the SS, since the assumption was originally made for all the products at the case site. The number of datasets used provides a reliable foundation, since it is more than one year of historical data. Using historical data from even further back in time could have resulted in misleading results, due to differences in for example the market environment and customer requirements at that time.

[2] 2015.08 – 2016.09

In this analysis, only the products with a life cycle code in an active state, since products with other codes are considered to be obsolete or being introduced recently and therefore their demand is not yet stable. The vast majority, over 99 percent, of the products have the active life cycle code. Thus, considering only products with the active status in this analysis is justified.

The analysis was made by summing all the products distributed from every DC to customers each month. The results from each month was analyzed, i.e. the share of products sent from each distribution to the customers, in order to see if there was large deviations or noticeable differences between the months. Afterwards, the results from each month was summarized into all the products sent from each DC, and then compared to the total amount of products distributed from the case company's DC to the customers.

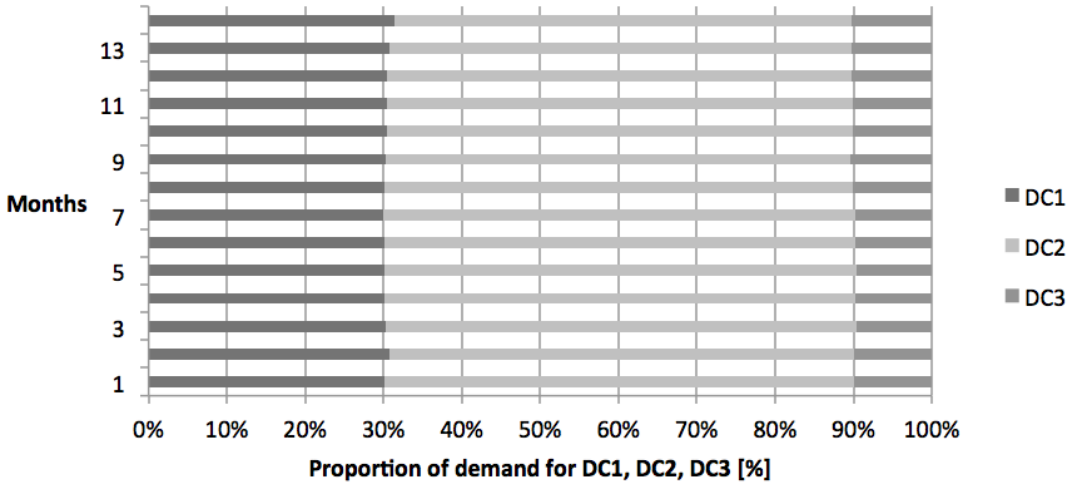

Figure 8. Geographical distribution of demand from each DC respectively

The findings of the analysis are presented in figure 8. The y-axis represents each of the 14 months, and the x-axis represents the proportion of demand between the DCs. As indicated in the right in figure 8, the different colors represents the different DCs. The most important findings from analysing the data is that the products delivered from DC1 is around 30 percent, products from DC2 is 60 percent and from DC3 10 percent. The median- and the average value are about the same and the deviation from this, i.e. minimum and maximum values, are diminutive. The motive to distinguish and consider median-, average-, minimum- and maximum-values was to ensure that no large deviations were overlooked, nor that the difference of the minimum and maximum value were unreasonable.

Each month analyzed separately are presenting fairly similar results, with small deviations. Due to the small deviations and a consistency betweeb the 14 data sets analyzed, the findings can be considered as reliable and hence more accurate than the current assumption of 35 percent, 55 percent and 10 percent respectively. A more accuate assumption would therefore be 30 percent demand from DC1, 60 percent from DC2 and 10 percent from DC3. The findings and the alternative recommendations will further be analyzed in section 5.1.

4.3.2 ASSUMPTION: DEMAND OF POM

The assumption that an SKU that is PoM will constitute 80 percent of the total sales in a SG, was examined. The current assumption at the case site is based on fair estimations and experience, rather than historical data. According to documents from conducted interviews, the assumption was made several years ago, and has been considered to work well enough since then. Therefore the assumption has not been evaluated or changed since it was implemented. As well as the assumption about the distribution of demand described above, the 80 percent assumption affects the calculations of ROP and ROQ, which are described in section 4.3. A poorly evaluated assumption can result in high stock levels, and thus in excessive stock, or even stock outs.

The dataset used to analyze this assumption is IMS data, which provides total sales to the end consumers on a national level for each SKU on an aggregated monthly level. The IMS dataset contains the sales at pharmacies to the end consumers, and thus it represents the actual demand required from the end consumers. It was desired to analyze the actual demand of the pharmacies from the case site, but this data is limited since competitors are handling some of the SKUs in the system. In most cases, several pharmaceutical distributors handle the SKUs within one SG, this means that there is lack of data what the pharmacies are ordering from the competitors and what the competitors can deliver. Therefore, the best option to get a full overview of the demand from the end consumers is through the IMS data. The drawbacks with using this data are that the pharmacies are in general ordering more pharmaceuticals than the quantity demanded from the end customers, to refill their own stocks, this quantity is not included in the IMS data.

Twelve sets[3] of IMS data were used, each containing sales for every SKU during each month. The sales of the SKUs in the same SG were aggregated. Every SKU that existed during the twelve months were included, even though some SKUs were eliminated or novel (i.e., SKU which was newly introduced on the market or in the SS) during the time. Then, the sales of the SKU that was the PoM in the SG, was compared to the total sales of the SG.

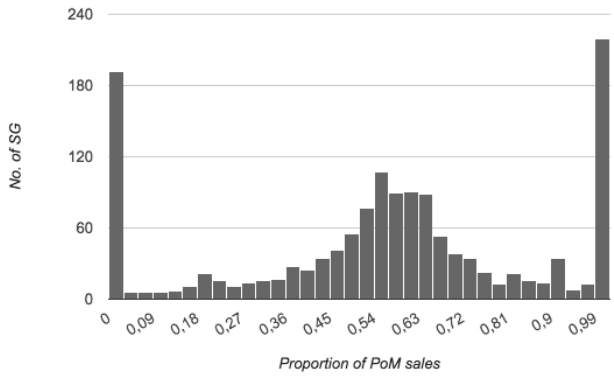

Figure 9. Evaluation of the PoM proportion of sales in a SG

The findings of the analysis, i.e. the proportion of sales from the PoM compared to the sales of the whole SG, from each SG was then aggregated. The findings are

[3] 2015.10 – 2016.09

presented as a histogram in figure 9. The x-axis in the figure represents the proportion of PoM sales in the SG, while the y-axis represents the number of SG. The histogram shows that in the most common case, the PoM constitutes either the sales of the whole SG, which is illustrated by the pile furthest to the right in the histogram, or that the SKU constitutes no sales in the SG at all, which is illustrated by the pile furthest to the left in the histogram. The reason why the PoM constitutes none of the sales in a SG, is due to that the SG did not have any sales during that time period. The most common reason why the PoM constitutes all of the sales in a SG is that there is only one SKU in the SG.

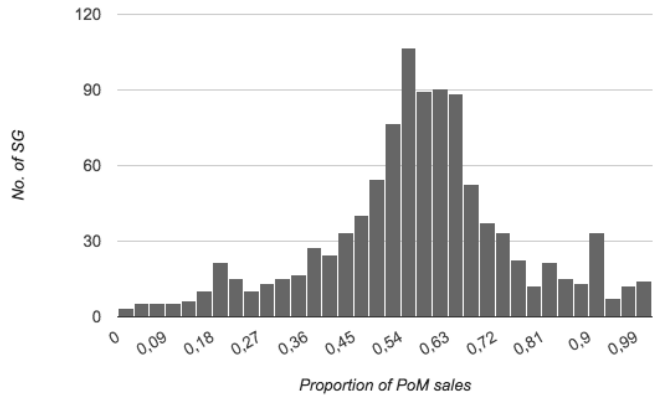

Figure 10. Evaluation of the PoM proportion of sales in a SG with extreme cases eliminated

The findings when the extreme cases of 0 and 1 have been eliminated, is shown in figure 10. The average value in this histogram is 0,56 and the median is 0,58. Thus, the current assumption that the PoM constitutes 80 percent of the total sales in each SG is proven to be inaccurate. However, it is highly prioritized to eliminate the risk of having stock outs, in order to ensure a high customer service level. If the assumption would be decreased to the average value, the risk of stock outs would increase, since there is still a large amount of SG where the proportion of PoM sales constitutes more that 56 percent. Therefore it is not appropriate to replace the current assumption with another general assumption for all the SG, but rather to find ways to adapt the assumption for the SG. This is further discussed and analyzed in section 5.2

4.3.3 IMPROVEMENT OF MANUAL HANDLING OF POM

To improve the manual handling of the PoM, the method presented in section 3.5 and figure 6 was used as a guideline. Mainly, the improvement of the manual handling was made by categorizing the SG. As showed in figure 6, the development included research, analysis and conceptualizing, testing, refining and selling. The last two steps building, and using and adapting was, as earlier mentioned, not part of this research. The research that formed the base for this categorization was presented in earlier sections. This section represents analysis and conceptualizing as well as testing and refining, since the development has been an iterative process.

Since there is no current standardization of how to handle the SKUs manually, the categorization was done in order to investigate which SKUs that contributed most to the risk of excessive stock. Due to the dynamic environment, as described earlier, no focus was kept on each separate SKU, since they are constantly introduced or

eliminated from the SS, and the demand of each SKU is highly fluctuating. The focus has instead been kept on SGs. In most cases, the SGs have a reasonable stable demand over time, even though the PoM changes and thus the demand for each SKU. Intuitively, it seem like demand is the most important criteria to consider when categorizing the SGs, since cost perspectives is not included in this research. However, several other criteria were identified and evaluated in relation to the case site to identify if they were essential as well. Firstly, criteria from literature and criteria recognized from the case site during the research, from interviews and observations, were identified. Following criteria were identified and used:

- Demand (average units sold per month)
- Variance of PoM in SG
- Seasonality
- Lead time
- Intermittent demand
- Substitutability
- Criticality
- Obsolescence
- Availability
- Repairability
- Durability
- Inventory cost
- Commonality

In table 4, all the criteria found in the literature and identified from studying the case site are listed and their applicability was compared to the case site. Cost is not included here, since it is not an important factor to consider in this research, mainly due to the case site's point of view since they do not consider cost as one of the more important factors. An evaluation was made for each criterion, whether it was applicable on the case site or not. The table presents each criterion's applicability and the reasons for it.

Table 4. Criteria and applicability at the case site

Criterion	**Criterion applicable at the case site**	**Comments**
Demand	Yes	The most essential criterion in this case
Lead Time	No	The time available to order is larger than the lead time
Variance of PoM in SG	Yes	Important, however in this case the categorization is made on SG-level
Seasonality	No	No considerable seasonality found
Substitutability	No	All the substitutabilities are within the same SG
Criticality	No	All SKUs considered as equally important
Obsolescence	No	Probability that all SKUs in one SG will become obsolete, and hence the whole SG, is very low
Availability	No	Not affecting the case site's part of the work
Durability	No	Not affecting the substitution system
Inventory cost	No	Not important in this evaluation according to the case site
Commonality	No	Not affecting the case site's part of the work

The lead time is not considered an important criteria, since the lead time is shorter than the time available, and thus there is enough time in general to order and recieve products when they are demanded. In this research, the lead time relates to the time to move units between CW and DC, and in general they are located next to each others. The variance of PoM in each SG is considered to complicate handling of the SKUs in a SG, when new products are introduced or existing ones are eliminated. Hence, it is applicable at the case site, but not used when categorizing the SGs. This is mainly since the difficulty to handle each SKU separately. Therefore this criterion is considered important and applicable at the case site, but it will not be used for further categorization. No seasonality of the SGs has been found at the case site, and therefore that criterion has been considered not important.

All the SKUs in a SG are considered to be substitutes to each other, and therefore the substitutability was not considered as an applicable criterion. Criticality has neither been considered as important, as it is difficult to rank the criticality of the SG mutually. It is highly unlikely that every SKU in a SG will become obsolete on the market, except in the cases when there is only one SKU in a SG. However, this is not common and hence the criterion was not considered applicable. Further, neither availability, durability, inventory costs nor commonality was considered applicable, since they are not related to the work of the case site, or since they do not affect the

PoM and the SS. Hence, the categorization of the SGs was mainly based on demand, since the most essential area is related to the amount of units in the DC. It was desirable to consider the demand from a demand pattern perspective. Although this was not possible to investigate due to the large number of SG and the individual patterns for each SG and for each month. Hence, these patterns would not contain consistent patterns and was therefore not considered further. According to Boylan et al. (2008) the area of demand categorization is an area that has received little attention over the years.

To perform a demand categorization, an ABC-analysis was made, to form a base for the categorization of the SGs. The base of the ABC-analysis was made from the Pareto principle, which says that 20 percent of the units constituting 80 percent of the total demand are considered important SKUs. Though, in this research the findings from the ABC-analysis were adapted to match the case site.

The ABC-analysis was executed using twelve months[4] historical data. The total sales from the 12 months from all the SG were compared to the sales of each SG during the same time period. The sales data from the previous 12 months were aggregated for each SG to one summarized value, which represents the total sales from all the 12 months. The value of the total sales for each SG was then compared with the total sales for all SGs. A percentage for each SG was generated and compared mutually. No consideration was taken to what SKU that was PoM each month, in some cases there was not even a PoM in some SG. From this it was found how large share that each SG constituted related to the total sales of all the SG. The result of the ABC-analysis is illustrated in figure 11.

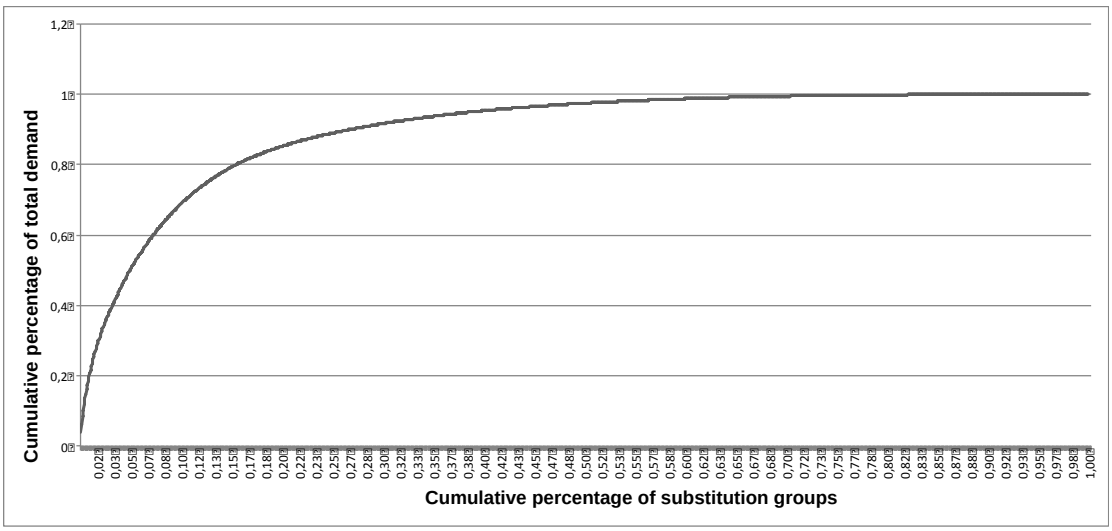

Figure 11. The share of the SGs proportion of total sales

The x-axis in the figure represents the share of all SG on an aggregated level, with the SG sorted in descending order. The y-axis represents the share of the total demand of the SG. The data contained information about the sales volume for each SG on a unit level, i.e. the data compared was in number of units. One unit is referring to one package of the pharmaceutical. Even the size of the packages differs, and hence occupying various space, this was disregarded. The purpose of the ABC-analysis was

[4] 2015.10 – 2016.09

to investigate how large share of the total sold units that the largest SG constituted. The largest SGs, measured by the number of units sold, were the interest since they are creating the largest share of the work in the DCs, as well as they are occupying space in the overcrowded warehouse space in the DCs. The findings from this analysis are aimed to be used in the improvement of the manual handling at the case site. The most prioritized SGs are those with a large sales volume, and hence large demands, in order find a way to minimize the handling of units that are not demanded by the end customer.

The most essential findings from the ABC-analysis are illustrated in figure 12. One important finding was that 15 percent of the SGs with the largest sales volume constitutes 80 percent of the total sold units. Another finding from the ABC-analysis was that 12 of the largest SGs constitutes 20 percent of the total sales, even they only represent less than one percent of the total amount of SGs. Since these 12 SGs are considered to be a rather small share of the total amount of SGs, they should be prioritized during manual handling, for example when revising the quantities moved from the CW to DC, to minimize the risk of moving more units then demanded. The SGs that were not within the largest 15 percent, are considered to be less important, where 85 percent of the groups are representing 20 percent of the total sold units and are thus less considered and analyzed in this report.

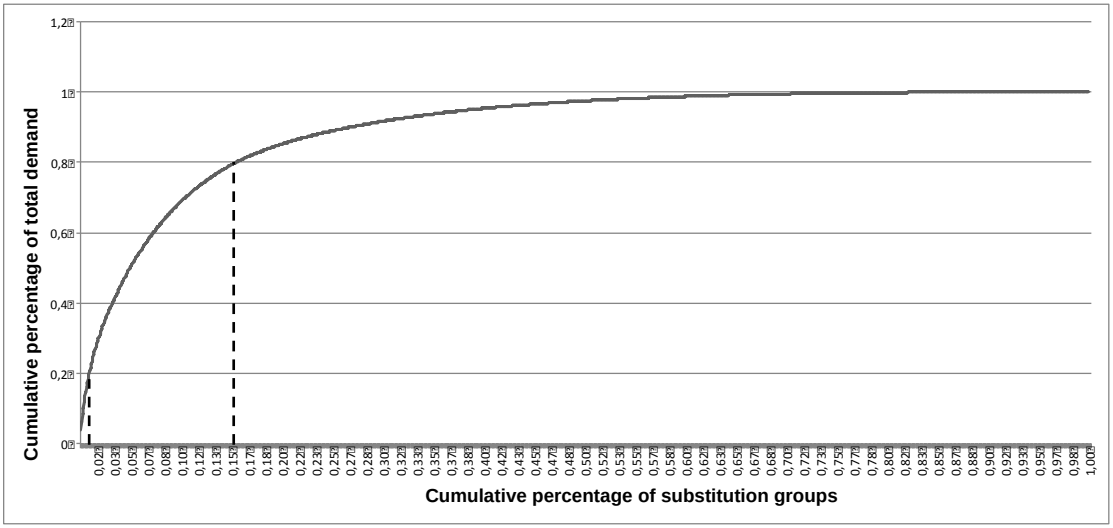

Figure 12. The share of the SGs proportion of total sales with ABC-categories

Findings of the analysis where the most essential values are marked in figure 12. One percent of the groups constitutes 20 percent of total sold units, and 15 percent of the substitution groups constitutes 80 percent of total sold units. The division of SG in each category A, B and C is shown in table 5. In these categories, the SG was only based on demand.

Table 5. The categories and their shares respectively

Category	**Share of total products [percent]**	**Share of total SG [percent]**
A	20	1
B	60	14
C	20	85

This analysis was made with the aforementioned data, which represents 12 months. If more months were to be included, another result could have been achieved. Though, it is credible that the ABC-analysis provides reliable results. Since it is based on the 12 previous months, from the time the research was made, it is likely updated to contemporary trends and demand patterns of the market.

The total amount of SGs used in the analysis was over 1000, all the SGs were present during the aforementioned time period. Some of the SGs were only active during one or a few months, while others were active during the whole time period of 12 months. Reasons why some SGs only were active during one or a few months was either that the SGs are new in the SS, or that they were eliminated and no longer in the system. The reason why they were eliminated can be due to several different reasons, for example because they are obsolete or that they have been eliminated due to competition. For the SGs that were not active during the 12 months, the result of the analysis may not be equitable. Though, the main purpose of the analysis was to find the groups with the most units sold, and hence the largest demand

5. ANALYSIS

In an optimal case, the identified improvement areas presented in this research, including the methods for forecasting and the inventory control should be included in the ERP-system at the case site. However, this is not feasible in the current case site due to several reasons, for example due to prioritization of resources. Hence, this chapter presents the opportunities of how the identified improvement areas can be enhanced by using alternative and additional methods to the currently ones used. The analysis will cover what was presented in chapter 4, i.e. the assumptions about distribution of demand and demand of PoM, and improvement of manual handling.

5.1 ANALYSIS: DISTRIBUTION OF DEMAND

Analysis of the findings shows that the assumption about the distribution of demand should be adjusted from the currently used assumption. By examining historical data, it was justified that the current assumption is not aligned with the actual geographical distribution of demand. The result shows that instead of using the current assumption of 55 percent from DC2, 35 percent from DC1 and 10 percent from DC3, the assumption should be adjusted and instead 60 percent from DC2, 30 percent from DC1 and 10 percent from DC3 should be used.

To enhance the current assumption, three possible measures have been identified and could be implemented. The first possible measure, is to simply change the current assumption from today's 55-35-10, to 60-30-10, which was shown to be more accurate than the current assumption, with the basis in historical data. However, it is possible to avoid the assumption entirely, by using the information from the ERP-system instead. The ERP-system enables dynamic determination of distribution of demand, i.e. from which DC the products are requested and thus the geographical area they are related to, hence the assumption would not be needed. However, due to several reasons, it is difficult in practice to incorporate this function into the ERP-system. As described in subsection 4.1.1, the ERP-system requires a minimum of three months historical data in order to generate forecasts, hence the system is currently limited in terms of sufficient data storage. The assumption about the distribution of demand is used in the external program when calculating the daily forecast, together with other assumptions, and is done since there is lack of actual historical data.

The data used to examine the current assumptions was data from the ERP-system. The third possibility would be to examine each SG separately, and hence use historical data from each SG to distinguish the distribution of demand for each SG. Though, as mentioned before, even though this alternative would lead to the most accurate results, it would not be possible in practice.

The findings were based on not only SKUs in the SS, but on all the SKUs at the case site handled with the active life cycle code. The difference between the demand of SKUs in the SS-system, i.e. pharmaceuticals on prescriptions, and other SKUs sold at pharmacies, should not differ widely. There might be a difference in demand for certain SKUs, for example if some geographical locations has more sun hours per year than others, the demand for sunscreen might be higher in those areas. However, such elements should not affect the assumption since they are considered to be negligible.

5.2. ANALYSIS: DEMAND OF POM

The findings show that the currently used assumption, a PoM constitutes 80 percent of the total sales in a SG, is not aligned with sales data. The findings from analyzing the assumption using historical sales data shows that there is a widely-spread distribution of how large part the PoM sales constitutes of the total sales in a SG. Therefore, it was not appropriate to replace the current general assumption with a new general one, but instead to adapt the assumption for the SG depending on their characteristics.

To enhance the assumption of proportion of sales of PoM in a SG, and thus generate more accurate forecasts, several different measures can be implemented. It is desirable to incorporate the forecast process of all SKUs in SS in the ERP-system, though this is not feasible today. Therefore, other measures have to be implemented to enhance the generated forecast. One measure to implement is to base the assumption of the PoM on the months when it has previously been PoM, and thus do a separate forecast for each SKU. However, this can be difficult to implement. In SGs that contains a large number of SKUs, there are often large gaps when a specific generic is PoM. If the forecast would be based on the months when the SKU was PoM, the data collection might reach several years back to collect enough data, and thus the data may not be reliable since it is considered obsolete and therefore not representing the current demand. Another drawback with using this measure would be that an assumption for each SKU would be necessary.

Another measure that could be implemented is to handle the SG where the PoM constitutes either zero or 100 percent of the sales separately, accordingly to the findings. The SG where this do not apply, i.e. the SG where the demand of PoM is larger than zero but less than 100 percent, another measure should be implemented. When the extreme values are eliminated, the average proportion of the sales of a PoM in a SG is 56 percent. However, to make an assumption that this would apply to every SG would not be correct. In that case, a large proportion of SG would be underestimated regarding the sales of PoM, and an increased risk of stock outs would appear. At the same time, a large amount of SG would be overestimated. Hence, making an assumption of 56 percent would not be accurate nor contribute to improving today's method. Instead, the SG where the PoM sales constitutes more than 0 percent but less than 100 percent, can be divided into groups. Figure 13 illustrates one example of how those groups could be divided, in the figure six groups are divided. The figure shows that SGs where the PoM sales constitutes 0 to 30 percent of the total sales in the SG, the assumption should be made that all of these SG has a proportion of PoM sales of 30 percent. This entails that the largest part of these SG will be overestimated regarding the proportion of sales of PoM in the SG but non will be underestimated, which is the leading priority.

Further, the SG where the PoM sales constitutes between 30 and 60 percent, will all be assumed to constitute 60 percent. Hence, a large proportion of the SG is again overestimated but the risk of stock outs are optimized. The same applies for SG where the PoM constitutes between 60 and 75 percent of sales, all of those SG are assumed to have a PoM proportion of sales at 75 percent. The fifth group in figure 13, where the PoM sales constitutes between 75 and 99 percent will be assumed to constitute 99 percent. The extreme cases, where the proportion of sales constitutes either zero or 100 percent, will be handled as group 1 and 6.

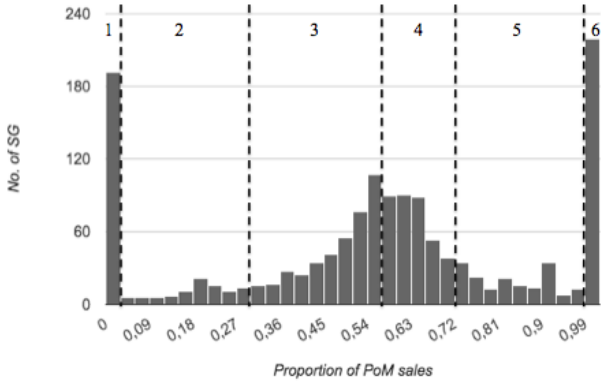

Figure 13. Division depending on the proportion of PoM sales in SG

The more groups the SG is divided into, the more accurate will the assumptions be. However, the more groups that are established, the more resources are required to use when dividing the SG into groups, which can also increase complexity of the system. This division of SG is a measure that can be used that do not require special development, but it is a simple measure that can be adjusted in the external program currently used.

The daily forecast of an SKU is calculated in the external program, as described in section 4.1.1. The forecast is calculated using MA, and then multiplied with the two assumptions about the demand of PoM in a SG, and the distribution of demand geographically. The two assumptions used together, has higher risk to generate an even more inaccurate forecast. Since non of the two current assumptions are based on historical data, but rather experience. Incorrect parameter based on the current assumption can result in forecast inaccuracy and a combination of two incorrect parameters may even lead into more severe forecast inaccuracy.

5.3 ANALYSIS: IMPROVEMENT OF MANUAL HANDLING

In order to improve the manual handling of the SS, and the PoM, a categorization was performed. Due to the use of multiple systems and lack of system integration, manual reviewing is inevitable since constant review of the generated values need to be controlled and improved. By performing a categorization, the most important SKUs were identified. However, the categorization was not based on SKUs but the SGs, since they were considered to be less dynamic than the SKUs.

The findings show that demand is the only and the most important criterion when it categorizing the SGs. The SG in category A has a high importance and high prioritization of manual review. Since category A only includes a few SG, which are constituting one percent of the total amount of SG, manual review of these SGs should be made extra carefully each PoM cycle, since they are contributing to a large share of the total units. Hence there is a large risk of excessive stock due to category A constitutes 20 percent of the total demand in units. By prioritizing manual reviews of SG in category A, there is a great possibility that the stock levels can be more controlled, and hence risk of over stock can be decreased. Category B constitutes 14 percent of the total amount of units. Thus, in this category it is difficult to review each single SG manually. Though, the category constitutes 60 percent of the total amount of units and a review could be made if some of these SGs should be included in the

frequent manual review with category A. In category C, more then 1000 SGs are included, and the category constitutes 20 percent of the total amount of units. The category C constitutes 85 percent of the SG. This category should hence not be prioritized with manual review. The contribution of the manual review would be so low due to the large amount of SG and the relatively low amount of total units.

The result of the findings at the case site shows that demand of the SKUs is the only relevant criterion to consider when categorizing the SKUs. Due to the current environment, the demand is the only crucial criterion. Several criteria were evaluated during the research, to ensure that all the possible criteria were considered. Anyhow, the only criterion that was considered important related to the current environment was demand. Depending on goal and aim of the company, the categorization can be adapted. However, since the current aim is to minimize the risk of excessive stock, the single matter should be the number of units in stock, and thus the SG with the largest demand entails the largest risk. This is due to that a miscalculation of the number of units transferred between CW and DC can have severe consequences, and especially when there are SGs with large demand.

The categorization of the SKUs presented in this report can be used when manually revising the SKUs. By categorizing the SKUs, the most important SG, i.e. the ones that have the largest demand, and thus the largest SG, in category A, can be continuously revised every month to decrease the risk of having excessive stock. The revision should be done complementary with the currently used systems. Since category A only contains a few SGs, the manual revision does not require extensive resources and can be made in every PoM cycle.

6. CONCLUSION

In order for a firm to optimize their supply chain performance and meet the customer requirements, certain improvements can be implemented to enhance the current performance. This chapter includes a summary of the findings in the research, as well as a reconnection to the research questions presented in section 1.5.

Due to a highly dynamic supply chain, an optimal solution to a specific problem was not possible during this research. Therefore, methods and tools have instead been proposed to improve the handling of PoM and the SS. The most optimal measure to suggest in this research would be to exclude the external program and incorporate all the forecast- and inventory control activities into the ERP-system. By doing this, the two current assumptions evaluated in this research could be eliminated, as well as the need for manual reviewing of the generated inventory levels. By incorporating all the forecast activities in the ERP-system, each SKU could be evaluated which forecast method that suits best. For example, a function in the ERP-system could be included where the most suitable forecast method was to be evaluated on a regular basis for each SKU. By selecting appropriate forecasting methods for each SKU individually, it would be possible to eliminate some of the current assumptions used.

Since it is currently not possible to incorporate all the inventory control and forecast functions into one system, the conclusion of certain measures can be taken. The elimination of manual tasks is not possible and therefore an analysis was performed on which SKUs and SG to prioritize. Certain assumptions are still necessary if the current multiple systems and forecasting methods are used. Two of the assumptions have in this research been evaluated and recommendations for improved assumptions were given. General assumptions of the SG should be minimized and instead asumptions on an individual level should be made. Due to the large number of SG and the dynamic environment, it would not be appropriate to perform individual assumptions and handling for all SG. However, it can be individualized into categories based on the SG characteristics.

It was proven that demand categorization was appropriate when categorizing the SGs to improve the manual handling. In literature, it is stated that demand categorization is appropriate in cases when costs are not in focus, but rather demand is. The most important characteristics of how to classify the SGs and their mutual importance in this research were through demand.

RQ1: What planning processes and methods are currently used at the case site?

The case site is currently using multiple methods, both an external program and an ERP-system. The external program was developed since the ERP-system has certain constraints when generating forecasts. Certain codes are used to distinguish which of the two methods to use for each SKU, and the codes are updated every month. Often, the codes for each SKU are changing monthly and hence the method used for the SKU is changed.

Different data is used for the two methods. The ERP-data uses sales data from the case site to pharmacies, while the external program uses sales data from the pharmacies to end customers on an aggregated national monthly level. The usage of this data requires certain assumptions in order to generate a forecast and inventory control levels for each SKU. The external program also requires continuous manual

review of the generated values, which is currently not standardized but reviewed randomly or when required from customer.

RQ2: What improvement areas related to the planning processes and methods can be identified?

In order to find the causes for the risk of excessive stock at the case site, an investigation to find the causes was made. The findings showed that both internal and external elements were causes to the risk of excessive stock. The main external elements affecting were a dynamic supply chain and the presence of competitors. The reasons for the dynamic supply chain were for instance the large monthly demand fluctuations and the dynamic pharmaceutical market, where pharmaceuticals are introduced and eliminated on a frequent basis. The presence of competitors entails information gaps for the case site, and therefore the case site experience difficulties in forecasting. The main internal elements that contributed the risk of excessive stock were usage of multiple systems, the arbitrary assumptions based on experience and ”good enough”-parameters rather than actual sales data, and the lack of standardization for manual handling. The identified improvement areas and their interrelations, illustrated in figure 7, were all considered to contribute to the risk of excessive stock at the DCs.

RQ3: How can these areas be improved, in order to optimize the business performance while meeting customer requirements?

Several of the identified improvement areas were further investigated and analyzed, including two of the currently used assumptions and the lack of standardization of manual handling. One measure that would optimize all of these improvement areas would be to incorporate all the functions of the case site into the ERP-system, and hence only use one system and therefore minimize the manual handling and the need for currently used assumptions. However, since it is not currently possible to incorporate everything into one system, other suggestions were made.

The currently used assumption about distribution of demand among the DCs should be changed from 55 percent from DC2, 35 percent from DC1 and 10 percent from DC3, to 60 percent from DC2, 30 percent from DC1 and 10 percent from DC3. This is justified from analyses using actual sales data. The currently used assumption about that PoM constitutes 80 percent of the sales in a SG should be eliminated, and instead several different assumptions should be used depending on the proportion of sales PoM constitutes in comparison with the sales of the SG. Figure 13 illustrates a proposal of how the assumptions can be made instead, i.e. by dividing the SGs into groups based on their constitution of PoM sales in the SG. By making this assumption, the PoM in each SG can be more accurately calculated and the risk of excessive stock can be minimized.

To improve the manual handling, the SGs were categorized into three different categories by conducting an ABC-analysis. The categorization was done with the base in SGs instead of SKUs, since SGs have more constant demand compared to the SKUs. The SKUs are fluctuating highly in demand monthly, depending if they are PoM or not. The ABC-analysis was based on demand of each SG using 12 months historical data. The findings show that category A constitutes of one percent of all the SG and 20 percent of the total demand of all units. Hence, this one percent of SG should be reviewed continuously, in terms of the levels of ROP, ROQ, and forecasts

generated, to minimize the risk of excessive stock in the DCs. Category B included 20 percent of the total SG that constituted 60 percent of the total units, while category C included 85 percent of the SG that represented 20 percent of the total units. Hence, SG in category C should not be continuously manually revised, since it contains more than 1000 SG that contributes to a small share of the total units.

7. DISCUSSION

This chapter includes a discussion about the performed research. The work behind the research is reflected, it is discussed if another result could have been reached, as well as the areas that were not able to examine due to various reasons.

All the data used in this research was collected through conversational and semi-structured interviews, review of case site's documentations and archival records, and direct- and participant observations. If some of the data collection methods would be further used and more information could be used, this could have improved or developed the current findings. The interviews were made with representatives from the case site, TLV and a pharmaceutical enterprise. If more or other stakeholders would have been incorporated in the interviews, a broader perspective of the current case site may have been reached and hence affected the outcome of the research. During the investigation of two of the current assumptions as well as the improvement of manual handling, which was done through an ABC-analysis, 12 to 14 months data were used, due to data availability at that time. If another quantity of data sets would have been used, the result and findings could have been different. A larger quantity of data sets used could have led to impact of data that do not represent current demand structures, while a smaller quantity could have been to short to make any conclusions.

The research had a large focus on mapping the current situation, in order to understand and identify the causes to the risk of excessive stock, related to the PoM. The research was performed in a rather wide perspective where the focus was on identifying possible improvement areas, and analyzing three of the areas deeper. If the thesis workers would have been more familiar and have more knowledge about the case site and their current processes and methods prior the research, the research could have resulted in more deep and comprehensive findings.

8. CONTRIBUTIONS AND RECOMMENDATIONS

This chapter includes the contributions that the research resulted in. The recommendations that were given to the case site are described, as well as how the research has contributed to research.

8.1 RECOMMENDATIONS TO CASE SITE

The recommendations that was given to the case site are summarized in table 6. One recommendation was to develop their current ERP-system, and incorporate all the inventory control- and forecast calculation into one system to simplify the handling of the SKUs. The ERP-system should be developed to handle all SKUs, despite how long it has consistently been PoM or not PoM. Incorporating the functions into the ERP-system would decrease the complexity from using multiple systems, by eliminating the need for certain assumptions, such as the distribution of demand and the proportion of PoM sales in a SG, as well as the need for a large amount over manual reviews.

Table 6. Recommendations to case site

Measure to implement	**Result**
Development of the current ERP-system to omit the external program	Certain assumptions possible to eliminate, elimination of multiple systems
Adjustment of current assumptions	More accurate generation of forecasts and inventory control levels
Save codes	Information about which months certain SKUs have been PoM
Do continuous manual review of SGs with largest demand	Minimize the risk of excessive stock in DC

As an alternative to developing the ERP-system, other measures could be implemented. A recommendation about adjusting the assumptions examined was given. The first assumption that is currently used, about distribution of demand between the the DCs, should be changed from 55 percent from DC2, 35 percent from DC1 and 10 percent from DC3, to 60 percent from DC2, 30 percent from DC1 and 10 percent from DC3. The second assumption, that the sales of PoM constitutes 80 percent of the sales in a SG should be eliminated, and instead a division of the SGs should be made and the assumption should be made for each group. The suggestion is illustrated in figure 13 which contain six different groups, where each group have different assumptions about the proportion of PoM sales in a SG. By making assumptions for SG that has similar proportion of PoM sales in the SG, the risk of getting excessive stock or stockouts can be minimized.

The codes used to classify the SKUs are not saved today, which means that no information is saved about when a certain SKU was PoM or not PoM. It is possible to find which SKU was PoM a certain month, by reviewing the PoM lists released by TLV. However it is currently only possible to find by reviewing the lists manually. By saving the codes, information can easier be found about SKUs and when they have been PoM. This can be useful if the forecast method would change, or if any of the assumptions would change and based on different information than current one. If this is desirable in the future, the codes should be saved starting as soon as possible.

A recommendation about manually reviewing the largest SGs, in terms of demanded units, was made. The largest SGs were identified by using demand categorization and conducting an ABC-analysis. The recommendation was given to perform continuous manual review of the largest identified SG, to minimize the risk of excessive stock.

8.2 CONTRIBUTIONS TO RESEARCH

This research covers how the business performance can be optimized in highly dynamic supply chain in general. In particular, the research had a distributor's perspective and their demand planning processes in focus.

If the majority of elements affecting the supply chain are dynamic, and hence any suggested methods, findings or implemented processes cannot be based on those, but instead elements that are somewhat stable over time need to be identified. Although elements that are continuous over time and are affecting the processes cannot be identified, the elements that have some degree of consistency should be used. In order to implement some methods, consistent elements are required. If only the dynamic elements would be used, the methods would have to be re-evaluated constantly. Hence, this research has contributed to the general research that even in a dynamic supply chain, somewhat consistent elements have to be identified in order to suggest and implement new methods and processes.

When an ABC-analysis is made it is most commonly based on cost related criteria, such as the annual dollar usage. However, in environments where cost criteria are not considered relevant, demand categorization can be a suitable option. According to an article by Boylan, Syntetos & Karakostas (2008) the area of demand categorization has revieved little attention in research. Although the article was written several years ago, the most common criteria for ABC-analyses are cost related. This research has provided an example of where demand categorization is the most appropriate criteria to categorize SKUs.

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10. APPENDIX

10.1 INTERVIEW PROTOCOLS

Questions used at semistructured interview with purchasers at DC:

1. How do you work? What methods and tools are you using?
2. What manufacturers are you responsible for? How do you work with them? Do they usually have any specific requirements?
3. How much manual tasks do you perform? Is it required that you perform manual tasks?
4. How is ROP decided when manual adjustments is required?
5. How many SKUs are PoM?
6. How large share of the PoM comes from DIR suppliers?

Questions used at semistructured interview with the pharmaceutical enterprise:

1. Are you using fixed or random order quantities?
2. How does the replenishment process of the warehouses work?
3. How do you forecast future demand? What data are you using?
4. How do you prepare before holidays?
5. How is the reserve PoM handled?
6. Do you notice any distinct trends or seasonality regarding demand?
7. Does some SKUs have higher demand despite if it is PoM or not?
8. Are the purchasing decisions made locally or centrally?
9. What incentives do you have not to underestimate the future demand? Penalty fees?
10. How much do you cooperate with TLV?
11. What does the return flows look like? What are the rules you have to follow regarding the returns?
12. Do you think the distribution chain has room for improvement? How could it be improved?

Questions used at semistructured interview at DC2:

1. Are you using fixed or random storage locations?
2. How large amount of the units recieved here are reloaded and sent to SDU/SDG?
3. Do you have a logistics department? What do they do? Do you perform forecasting here as well?
4. What rules applies to the return flow?
5. How are units in the return flow handled? Are you sending it back to manufacturer, back to DC, CW?
6. Is the return flow larger for the generics compared with the other pharmaceuticals?
7. How do you place the PoM in the DC? Do you restructure the locations of SKUs in the DC every month?
8. How are you affected or limited by ROP and ROQ?

9. Is the DC replenished more often during the beginning of the month compared to the end of the month?

Questions used at semistructured interview with TLV:

1. How do you cooperate with the pharmaceutical distributors?
2. Your assignment is on behalf of the government, how often does this assignment change?
3. How do you include the pharmaceutical distributors in your change management?
4. When are the pharmaceutical distributors noticed if e.g. change occurs?
5. Do you work to decrease the need of the reserve PoMs? How?
6. Could the length of the PoM cycle be increased, to simplify the forecast processes etc.?
7. How does it work with the punishment fees to the manufacturers, if they fail to deliver the requested amount of PoM?
8. How does the manufacturers confirm that they are capable to deliver the requested amount of units (PoM)?
9. Do you consider manufacturers previous ability to deliver the requested units, when deciding the manufacturer to produce the PoM?
10. How do you manage shared PoM? How is it possible to have a shared PoM?
11. What happens if no SKU becomes the PoM? The reserve?
12. How do you work to prevent parallel import?
13. Do you forecast the need for PoM?
14. What happens if you over-or underestimate the demand for the PoM?
15. How does the process look like when pharmacies, manufacturers, or distributors reports lacking units of PoM?
16. Can the pharmacies affect the penalty fees?
17. How long can a PoM be unavailable, before the reserve becomes the new PoM?
18. Does a penatly fee always lead to that the reserve becoms the new PoM? What happens if there are no reserves?
19. How does the tender work?
20. If a reserve becomes the new PoM? What is the price of the new PoM?

Questions used at semistructured interview with process coordinator at DC1:

1. How does the external program and the ERP system forecast? What methods and processes are used?
2. How is ”number of days stockholding” decided?
3. How is the k-factor decided?
4. How is ”min/max days branch safety stock” decided?
5. Why is there two different ways to calculate the safety stock in the ERP-system?
6. How do you calculate MAD?
7. Is ROP calculated differently for supplier that has specific purchasing-days?