CHALMERS

Improving Demand Planning and Inventory Management

A Supply Chain Evaluation from a Distributor's Perspective

Master of Science in the Supply Chain Management programme

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Abstract

Increased competition and extended complexity of supply chains due to a more globalized trade have result in situations where efficiency and effectiveness of supply chains have been given more attention. It is no longer just about having the right products, it is about finding new ways of increasing supply chain effectiveness to improve customer satisfaction. Companies have nowadays started to realise that supply chains often account for a large part of a their costs, and more focus should thus be dedicated to find ways of how to decrease the costs related to supply chain activities.

Information is continuously streaming between different actors in a supply chain and it can be difficult for companies to utilize and collect all information efficiently. The visibility of information can sometimes be limited, while in other cases all the information needed is available, but there are no methods used to obtain the information. Finding methods for handling information can improve the overall supply chain performance, and improve the results for companies.

The study towards the case company was two folded. The first phase aimed to identify problems that caused unnecessary high costs where the case company had potentials for improvements within their sales, purchasing and logistics departments. The second phase was to analyse solutions and suggestions that possibly could improve the performance of the case company and reduce unnecessary high costs, and prove that new strategies could be used to reduce the identified problems.

To fulfil the aim and answer the research questions, a case study was conducted. Different data sources were used to get a deeper and broader understanding of the company's situation. Data was mainly obtained through semi-structured interviews with employees and through internal documents. The findings of the thesis showed that the company had potentials of reducing their high tied up capital and increase their turnover rate. The aim was therefore to find areas in their operations that could be improved to help increase the turnover rate and find ways of decreasing the number of products in their inventory. Empirical findings was analysed and compared with a comprehensive literature review to be able to find possible solutions to their main problems. The identified solutions highlighted in this thesis is deeper collaboration with carefully selected customers, improvements on their ABC-categorization method and implementation of an inventory management method which takes costs into consideration to improve the amount of goods purchased at each occasion. The common denominator for all the different areas of improvement is to use the information they have in a better way and find new ways to obtain more information. This creates the opportunity for the case company to increase the turnover rate and decrease tied up capital and reduces number of products in inventory.

The analysis showed that there are room for improvements. When introducing more relevant input to the ABC-categorization, it showed that there are many products with low margin stored in inventory. An implementation of an inventory management method showed that they will better understand and get indications of what quantities that is beneficial to purchase and thus can reduce costs. A deeper relationship with selected customers can increase possibility to obtain important information and ensure key supplier status among these customers. The study shows that using methods for utilizing the information in an efficient manner can increase efficiency and improve the performance.

Key words: Demand management, inventory management, supply chain performance, cost evaluation, customer relationships, multi criteria classification and economic order quantity.

Acknowledgements

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First off, we would like to thank the employees at the case company who has been involved in this project. The support and input from employees' through this project has largely contributed to the achieved results. We are also grateful for the support given by our supervisor at Agility, Johan Lindahl and the project manager Patrick Rawlings, who have been supporting us with feedback, ideas and good discussions throughout the project.

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Oskar Blomgren, Sandra Eriksson.

Abbreviations

APS- Advanced planning system

CPFR- Collaborative planning, forecasting and replenishment

EOQ - Economic order quantity

ERP- Enterprise resource planning

ROP- Re-order point

SKU- Stock keeping unit

SS - Safety stock

TC- Total cost

VMI – Vendor managed inventory

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1. Introduction

During this chapter the reader will be introduced to the study. The background to the thesis is presented which contains information about the area of study and the case company. Further on the purpose of the study and the research questions are described which consists of a short description why this area should be examined. Lastly, the scope of the study is motivated as well as a presentation of the outline of the report.

1.1 Background

Increased competition and more complex supply chains have led to a situation where efficiency of supply chains has been brought more attention (Prasad, 2011). Companies have started to realise that supply chain costs are often high, which is a reason for improving the performance of supply chains. According to Attaran and Attaran (2007) distributers, retailers and manufacturers have identified that supply chain cost reduction was a critical issue that should be in focus, which also proves that it is of great importance for many companies to decrease their supply chain related costs in some way. To create a successful supply chain it is of importance that companies adapt the different products to their demand and the supply chain should therefore be managed with regard to this variation. Companies that use a one size fit all strategy for their products will often not be successful with such approach (Lee 2002). To cover and plan for the uncertainties in demand in an efficient way is crucial for an organisation to not lose customers (Gupta, 2013). To be successful in inventory management, the underlying causes of the mismatch between sales and purchases needs to be identified. A way to do this is to evaluate the performance of the inventory. If the performance is not optimised, the service level, logistics costs and tied up capital will be higher than needed due to lack of planning and inventory control (Relph, 2015).

By grouping the different cost areas within the supply chain when evaluating the performance, the possibility of identifying the underlying problems that result in unnecessary high costs can increase (Sehgal, 2009). This was also stated by Akzaheim (2008) as an efficient way of identifying relevant costs that potentially can be improved. By applying the method, the most urgent problems can be brought up and evaluated to see if there are possibilities for improvements. By ranking the areas according to the most urgent, the problems can be addressed in accordance to its importance.

Finding improvement suggestions that prove that new strategies and methods are more useful compared to the current state, the company can gain competitive advantage and increase their performance. This by adapting the characteristics of the demand to suitable methods that will reduce the high costs. In turn, it can result in larger profit margins and overall improvements of the supply chain.

The tire- and rim industry has during the last decade faced an increased competition in the market due to new actors entered and the increased availability of products, which put high pressure on the supply chains. Customers are demanding short lead-times and a large range of variants of both tires and rims. This requires the supply chains to be flexible and adapted in order to fulfil the requirements from customers and not lose in sales. Due to the large seasonal variations that the tire business is facing during the year the demand is complex to manage. This since if a tire is not sold during its season it is an imminent risk that it will stay in inventory till next year. Due to the availability of tires in the market, the importance of holding the right items in inventory to avoid backlog and the risk of losing customers have increased.

Introduction of case company

Amring AB is a wholesaler of tires and rims with a warehouse located in Arendal outside Gothenburg. In total, there are 76 employees and the PON family, an international Dutch trading company with about 13000 employees worldwide, owns the company. The vision of Amring is to offer the best service and the widest range of products to the lowest price. The warehouse in Arendal is currently holding approximately 3000 different SKUs in tires and 1500 SKUs in rims. For the last years, Amring have faced problems with decreased margins, lost in sales and problems related to their supply chain and planning, both inside and outside the warehouse.

The reason for the negative spiral of losses can be derived back to the year of 2011, when Amring lost their brand Hankook that generated approximately 50-60% of their yearly turnover and sold volume. The strategy of the company was changed to instead become a "one stop shop" with a multi-brand strategy, rather than be dependent on solely one brand. One stop shop means offering a wide range of brands from different suppliers, to eliminate the risk and be able to offer the best service. This strategy has led to a situation where Amring has a wide range of variants of tires and rims in their warehouse. Their aim has been to have all kind of tires and rims available, independently on the volume sold for each season. In previous years, the company's financial results have been very strong and it has therefore not been considered as a problem to have a lot of items in stock. This problem has now caught up with them when the result of the company is not a strong as before. The strategy of one stop shop has led to a situation where they have a great number of tires and rims not sold, since customers are rarely demanding this wide variation. To further be able to understand the issue of this, the logistics manager explained during an interview an example of the complexity of tires. One car can for instance be capable of having approximately 5 different sort of tires, depending on dimensions, loading capacity and the speed the tire is supposed to handle. Therefore the balance can be difficult of which tires that should be kept in the warehouse and which should not.

The company realizes their need to reduce the tied up capital and to look over the strategy of a one stop shop and the fact that keeping all products in the warehouse is not optimal for their current business strategy. This, since they are going to improve the negative spiral and their losses by reducing their size of their warehouse in Arendal by 50%, which results in reduced tied up capital of products that possibly could be stored in the warehouse.

A new CEO was recruited to Amring to implement changes for the future. They have decided to outsource parts of their activities to Agility, a logistics service provider, to be able to improve the margins. The reason for outsourcing is mainly because Amring don't have the full competence within the area but also not able to make investments for the future. Agility will manage half of their warehouse in Arendal, so Amring will reduce their space to only operate on half of the area. This requires plans for how to reduce the number of SKU's in the warehouse to make the space available for Agility's operations. Amring also see the potential of using Agility and their services to make the company survive in the future, by for example getting better control of the activities and operations.

1.2 Purpose

The purpose of this thesis is two folded. First, the study aims to investigate and evaluate the current performance of Amring's supply chain, with focus on the sales, purchasing and logistics departments, to be able to identify problematic areas where unnecessary high costs in the supply chain potentially can be reduced. The next step is to find new strategies and methods that can improve the current situation to increase supply chain performance.

1.3 Research questions

Out from the above purpose, three research questions have been formulated for the thesis:

RQ1: What are the main weaknesses in Amring's current supply chain resulting in unnecessary high cost?

In order to better understand the current supply chain and how different departments are performing, it is of high importance to evaluate and get a grip of the organisation. Identifying the weaknesses and grouping costs is according to Sehgal (2009) an important phase since it lead to a situation where potential areas of savings are brought up. Continuously evaluating the performance is of utterly importance for a company to stay competitive, and to highlight improvement areas in order to find strategies of how to increase the profit and improve the results.

RQ2: Which inventory- and demand management strategies can be used to prevent and reduce unnecessary high costs, to increase Amring's supply chain performance?

For Amring to be able to create a new, improved supply chain, it will be of importance that they are given the tools to improve it with. Strategies that address the issues they currently have in their business will therefore be presented, so the company has the ability to implement new strategies that will improve their current supply chain performance and decrease unnecessary high costs. The meaning of strategies stated in RQ2 is connected to improvement methods of how to increase efficiency through inventory management and demand planning accuracy.

RQ3: What results can be obtained for Amring with the new inventory- and demand management strategies?

When suggesting new potential inventory management strategies and demand planning accuracy, it is important to prove that the results will be improved compared to the current state. Obtaining new strategies must be convinced by a better and improved result in order to show that new methods are beneficial to implement in comparison to the current performance. The result of the new inventory management strategies and demand planning will be highlighted in this research question as a complement to the two previous once.

1.4 Scope of the study

In order to achieve as good result as possible and get a study that could in the best way answer the research questions and improve the situation for Amring, the project had to be narrowed down. The selected areas in this study are considered to be those that can lead to the greatest improvement on the basis of the problems identified. Other areas that can be improved are left for future studies. The study has solely focused on supply chain improvements within purchasing-, sales- and logistics departments at case company, thus a complete review of their whole supply chain has not been carried out in this study. The performance of suppliers have been left out as well as the performance within the warehouse on a shop floor level and how other external parts are performing which might affect the result of Amring's performance.

This project has put focus on solely rims and tires, even if Amring stores other products as well. This is due to the fact that tires and rims stand for a significant part of sales during the year and affect the result a lot.

The study has only targeted the customers within Gothenburg. This due to the fact that it was considered too broad and time consuming to examine how other customers in other areas of Sweden could affect the result of Amring. It was also narrowed down to a specific customer which was one of the company's largest which was deemed to be of greatest interest for the study, hence not investigated how small customers could affect Amring.

Four examples of items used in the analysis of inventory management supplied from Europe can be seen in Appendix A. The reason for using item 1-4 in this study is that all items are representative in the manner of having the same lead-time from supplier and have been relative problematic to purchase for Amring during 2015, which is indicated by the misbalance between purchases and sales for item 1-4. The items were selected in collaboration with the logistic- and purchasing managers and were seen to be relevant for the time limit of the study.

1.5 Outline of the report

This master thesis consists of nine chapters. Below is a short description that will introduce the reader to each of the chapters and its content.

Chapter 1- Introduction
The introduction chapter will present a short background of the area studied and why this area is being studied. It also consists of an explanation of the research questions and the scope of the study.

Chapter 2: Theoretical framework
The theoretical framework contributes with the literature study for the thesis. The framework starts with a section about supply chain performance and cost management and follows by a section concerning inventory- and demand management, multi-criteria approach for categorisation and ends up with a section about customer differentiation.

Chapter 3: Method
This chapter describes the method used for the study. It starts by explaining the research method followed by the literature review. It further on describes how the data was collected and the method used for analysing the data. The last section includes a discussion of the reliability and validity of the research.

Chapter 4: Empirical findings
This section describes the empirical findings from the data collection. It presents the current performance in different relevant areas for the purpose and ends up with a summary of the main weaknesses and strengths in Amring's current supply chain.

Chapter 5: Analysis
The analysis will analyse the current situation out from the theoretical framework and empirical findings. It starts by identifying the weaknesses in the supply chain and continues with an analysis of the identified improvement areas and the new potential improvement strategies.

Chapter 7: Conclusion
This chapter summarizes the main findings from the study and connect to the research questions to make sure the purpose of the study has been met.

Chapter 8: Generalisation of study

The generalisation of the study includes a broader view of the study and how the areas of study can be used in other contexts and industries.

Chapter 9: Discussion and further recommendations
The final chapter includes a discussion about the findings from the analysis and suggestions for further research of the area and recommendations to the company. Difficulties as well as areas that possibly can be improved are covered, as well as a discussion of a generalisation of the study. It ends up with a risk analysis that is connected to the suggested strategies.

2. Theoretical framework

The following section covers the theoretical framework and models used in the study. All references are collected from existing literature. The framework includes chapters about supply chain performance and cost management, forecasting and demand management, inventory management, categorisation of products and ends up with a chapter about customer differentiation.

The framework presented in the study contributes to the understanding of the fields used in the analysis of Amring's inventory management and demand planning strategies. The approach can be seen in Figure 1 where all relevant areas are stated and how they are related, to increase the overall understanding.

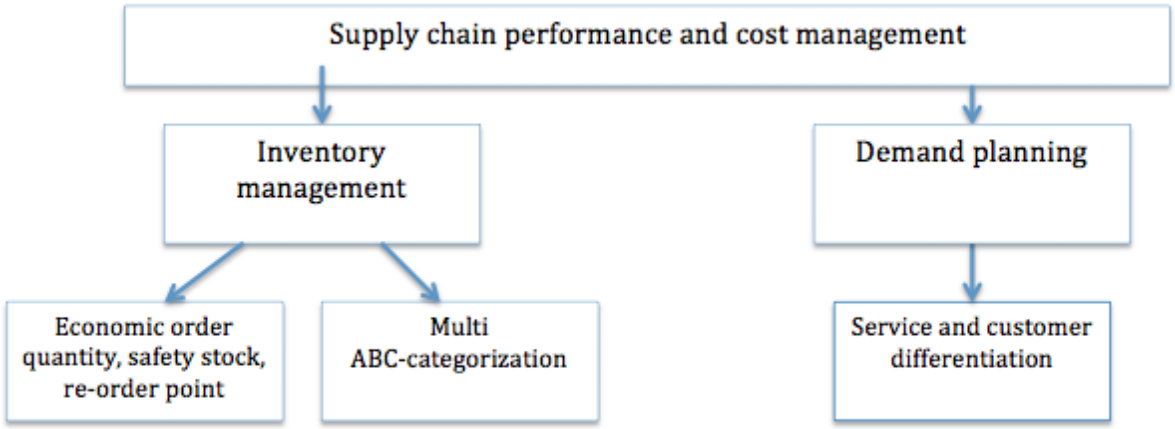

Figure 1. Approach of theoretical framework

2.1 Supply chain performance and cost management

Supply chain management has over the last decade emerged as one of the larger areas where companies can create a competitive advantage. But managing a supply chain in an efficient way is a complex and challenging task, this due to for instance expanding product variety, outsourcing, and globalization of business (Lee, 2002). The increase in competitiveness in the business world and the fact that more complex networks and supply chains have occurred during the last decade has led to a situation where efficiency and effectiveness of distribution has been brought more attention (Prasad, 2011). If companies phases the pressure of unnecessary high inventories, decreased customer service, increased costs and declining profits, their supply chain is not in control. If businesses are moving into new markets or will start using new techniques, it must have its supply chain prepared for the new challenges and opportunities they may face. To create a successful supply chain it is of importance that companies understand that different products often have different demand and the supply chain should thus be managed with regard to such variation. A product with a stable demand and a reliable source of supply should not be managed in the same way as a product with unpredictable demand and an unreliable source of supply. Companies that use a one size fit all strategy for their products will often not be successful with such approach (Lee, 2002).

By limiting unnecessary losses caused due to production, distribution planning and improper routing of vehicles the costs throughout the supply chain can be reduced (Prasad, 2011). Cost

management in a supply chain has previous focused on managing the activities and transactions that causes the costs. Today it is of equal importance to prioritise the management of the decision makers, since the success depends on the interactions between different levels and departments within an organisation (Goldbach, 2002).

Anklesaria (2008) point to the importance of involving the organisation on the same ground when evaluating and optimising the costs, and the importance of designate project groups to evaluate the costs. Visualising the activities by using a goal specification sheet, all cost activities throughout the supply chain can be highlighted and thus are easier to improve. A map of the current supply chain is also a way to visualize the activities, and thus easy to identify the costs. Potential costs to optimize in a supply chain are summarized in table 1 which exemplifies what costs are included by breaking down all costs included in a specific activity. Depending on the willingness to share data, the costs can be more or less accurate.

2.2 Forecasting and demand management

Bona (2014) means that planning for variations in demand and the prediction of future demand is an important phase in the resource planning since it supports other planning functions such as production planning and material requirement planning as well. Since markets are today changed in a rapid pace, it requires supply chains to be flexible and efficient. This can be derived to the uncertainty of customer's demand but also the increased customer expectations. To cover and plan for uncertainties in demand is crucial for an organisation to not lose customers (Gupta, 2013).

There are different kinds of uncertainties in demand, both in a long time horizon but also in the short run (Gupta, 2013). Short term uncertainties could include day-to-day variations in processing, cancelled or rushed orders, equipment failure etc. In long term the uncertainties can be referred to price fluctuations in raw material/final product units, seasonal demand variations or production rate changes. Underestimating the impact of uncertainty can lead to situations where decisions regarding planning don't secure a company against the threats only use the benefits of the opportunities provided by higher levels of uncertainty. An example of this could be the uncertainty of product demand in a production-distribution system. If the fluctuations in demand are not considered it can lead to unnecessary high inventory holding costs or unsatisfied customers due to loss of market share and risk of backlog. Both of these scenarios are highly undesirable in current market settings since margins for profit are very tight. The statistical forecasting is the first and most critical step in demand planning, which is a complex process. The effectiveness of traditional methods depends a lot on the variations in different organisations and their economical environments (Bona, 2014). Lack of planning systems that consider the uncertainties in future demand forecasts can expect to result in poorer planning decisions compared to models that account for the uncertainty (Gupta, 2003).

Bullwhip effect in supply chains

According to Lee et al (2009) there is a risk of receiving misinterpreted information throughout the supply chain when information is transferred from one end to the other. The numbers used in one end might be calculated based on information given from the step before, and is not based on data from the end of the supply chain or point of sales data. Therefore larger variations and fluctuations is increasing further back in the chain, the so-called bullwhip effect occur. This can lead to situations with misguiding capacity plans, ineffective transportation, poor customer service and missed production schedules which can lead to loss in revenues. The numbers used further back in the chain will be less accurate compared to the real sales data. To mitigate the

risk of using numbers that lead to mismatch with the real data, sharing of point of sales information can reduce the risk of misguiding numbers.
Common symptoms of variations in demand could be excessive inventory, poor product forecasts, insufficient or excessive capacities, poor customer service due to unavailable products or long backlogs, uncertain production planning and high costs for corrections (Lee et al, 2009).

Hvolby (2002) means that by making it possible to include supplier and customer relations into the planning procedure it is possible to optimise the whole supply chain on a real time basis. This will reduce the bullwhip effect and base the planning on real time data. Advanced planning systems (APS) support planning in a collaborative environment with many partners included in a network that has shared access to information both from suppliers and customers. The aim of the planning system is according to Hvolby (2002) to support activities such as:

- Allocation of capacity in production for different production locations
- Allocation of products to different production locations and planning and optimisation of companies goods flow
- Integrated inventory management

Managing uncertainties in demand
According to Gupta (2003) it is important to add the uncertainty into the planning decisions. This can be derived back to the core function of planning models, to allocate resources for the future based on past data and current demand to be able to estimate for the future. To integrate uncertainties into planning decisions, the most important part to consider is the determination of the most suitable representation of these uncertainty parameters. Ashayeri (2006) means that a demand forecast would never be perfect due to market dynamics and forecast errors that are unpredictable. That is the reason for not only including historical data in the forecast (Ashayeri, 2006).

To avoid uncertainties in demand, a company can cope with two strategies. It can either position itself as an adapter or shaper. In the shape strategy, the aim is to restructure the distribution of demand in order to limit the associated downside risk while the potential of benefits are taken. This can be achieved through agreements and contracts with customers, who could include an agreed quantity offer of supply with a minimum/maximum amount to the customers and in return they get offer of a price discount of the products. The adapter strategy, on the other hand, does not influence the uncertainty level in the market. It only controls the risk exposure of this to happen, such as profit margins and stock levels, by constantly adapting the operations to the demand (Gupta, 2003).

Demand planning
It becomes easier to plan for changes in demand if companies understand the demand and the expectations of the customer. Kotler (2003) defines demand management as the responsibility of the marketing organisation which means demand forecast is the result of a planned marketing effort. Planning should not only simulate demand but also influence demand in order for companies to achieve their objectives (Crum, 2003). When evaluating demand planning, two main aspects need to be considered: materials and resources. The relation between these two sets the limit of how to prioritise and influence demand.

Crum (2003) means that if companies better can understand what drives the market and customer expectations of products, services and pricing requirements, companies can progress

a more correct forecast. Sales and market departments can also benefit from this when positioning the company on the market. A broader view of the demand makes the company a stronger competitor. The broad view model of demand management consists of four areas (Figure 2) that all should be highlighted when managing and planning for the demand.

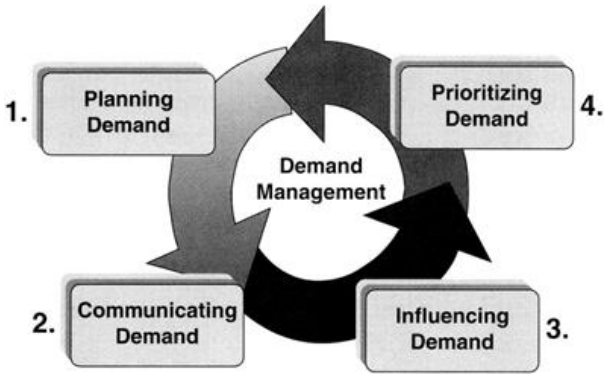

Figure 2. Broad view of demand management (Crum, 2003)

By integrating the elements and include information about processes, a comprehensive view of demand can be achieved. When the broader view of demand management is used, it is important to consider that as an on-going process repeated in time. The accuracy of demand forecasts will be improved if understanding the four elements included and the interaction of the components (Crum 2003). The first step is to plan for the demand, including data collection and a review of what the customer wants. Planning for variations in demand is crucial according to Ashayen (2006) and also to involve the whole organisation in decision-making. By communicating the demand internally and externally, a better plan can be estimated and the errors in the forecast can be reduced if the awareness of the changes are brought up (Crum 2003). The influence of demand is being evaluated to clarify the impact and effects and how they possibly can be manage the best way. The final step in Figure 2 includes prioritizing the demand, and if it is not considered as an important issue to highlight the forecast will be less accurate since you need to prioritize and carefully adapt and manage the demand variations.

It is common when only one department is responsible for forecast that it includes only historical shipment data, especially when the supply organisation is given forecasting function or when demand history is not available. This method gives less accurate forecasts, since shipment history does not include when customers wanted the product to be delivered or important information about demand. There is also a risk of bad forecasts if the people responsible for forecasting in the supply organisation are lacking knowledge of marketing and sales activities (Crum 2003).

Ashayen (2006) means that developing a successful demand plan requires the involvement from logistics, marketing and sales department. According to Crum (2003) the difference between failing or succeeding in demand planning is whether the sales and marketing people actively participate in the process or if they delegate the responsibility to others lower in the organisation. When starting a project the aims to develop an improved demand plan, all parties from the different departments need to be convinced to make the collaboration work (Ashayen, 2006).

2.3 Inventory management

Inventory is according to Relph (2015) described as “all the goods and materials that an organisation owns or holds, and to which a business intends to add value before selling”. The

problem with holding inventory is often what quantities and how many variants that needs to be stored. A lot of capital is tied up in inventories, from which the company need a good return on on-going investments. It is common to use computer systems to manage the business and inventory levels. Computer systems that help to manage the inventories are often problematic since they are failing in effectively synchronising the strategy of the business with the detailed inventory management decisions (Relph 2015).

To be successful in inventory management, the underlying causes of the mismatch between sales and purchasing data needs to be identified. A way to do this is to start measuring the performance of the inventory. Factors affecting the inventory levels are forecast accuracy, delivery time, delivery precision and inventory balance accuracy. If the performance is not optimised, the service level, logistics costs and tied up capital will be higher than needed due to lack of planning and inventory control. The inventory levels are adapted out from the different characteristics of the product such as service level, batch sizes, lead times, suppliers per item and demand variations (Relph 2015).

Palmatier (2003) means that the use of planning systems for scheduling and planning for order quantities are crucial for organisations to keep the inventory levels as low as possible. Planning systems makes it easier to include the organisation in the decision-making and to schedule for the future demand. The tactics a company strive for in their operations needs to be agreed upon between all departments to reduce misunderstandings since it often results in higher costs than needed. Inventory levels can be reduced and optimised when following occurs (Palmatier, 2003):

- Forecast errors are reduced
- Demand variability is reduced
- Possibility to be flexible in capacity increases

Inventory turnover rate

When the performance of an inventory will be evaluated, it is impossible to use numbers such as tied up capital since it is not representative to compare between other inventories. A more representative measurement number is to compare the inventory turnover rate, since this measurement means that the actual numbers are comparable even if the inventory or department is of not exactly the same sort. Inventory turnover rate measures the number of times the average inventory is annually turned over. It express the total material flow during a certain time period in relation to the capital that in average is turned over during the same period from last year tied up in the actual flow. The inventory turnover rate can be calculated from the formula (Jonsson and Mattsson, 2011):

$$Inventory\ turnover\ rate = \frac{Annual\ consumed\ quantity}{Average\ number\ of\ units\ in\ stock}$$

According to Jonsson and Mattsson (2011), it is more common to calculate the inventory turnover rate for a group of products or for all products in inventory rather than for a specific item. The turnover is then expressed by the deliveries from inventory during a specific time period and the average tied up capital. A practical problem here with calculations since the calculation of the annual turnover is based on the items sales price, but the value in inventory is based on the cost price of the item. To get a correct calculation of the inventory turnover rate the same unit needs to be used, otherwise the increase in sales price will not result in a higher

average inventory, which is not correct. Therefore the following formula is more correctly used when calculating the inventory turnover rate (Jonsson and Mattsson, 2011):

$$Inventory\ turnover\ rate = \frac{Annual\ deliveries\ expressed\ as\ cost\ of\ goods\ sold}{Average\ tied\ up\ capital\ in\ the\ material\ flow}$$

2.3.1 Inventory management method with optimal order quantity

According to Jonsson and Mattsson (2011), methods used out in industry for calculating the most optimal quantity to place on each order are usually evaluated in accordance to if the order quantity is fixed or varying and compared to if the time the order quantity is meant to cover is fixed or varying. This evaluation can be seen in Figure 3. If using a fixed order quantity, each order represents the same order quantity from time to time. Since the quantity is fixed, the time until the next order is placed must vary from time to time. The meaning of fixed order quantity does not usually mean that the quantity is never changed, it only indicates that it is not adapted to the actual needed situation. The provided method for calculating the quantity needs to be continuously updated with current parameters (Jonsson and Mattsson 2011).

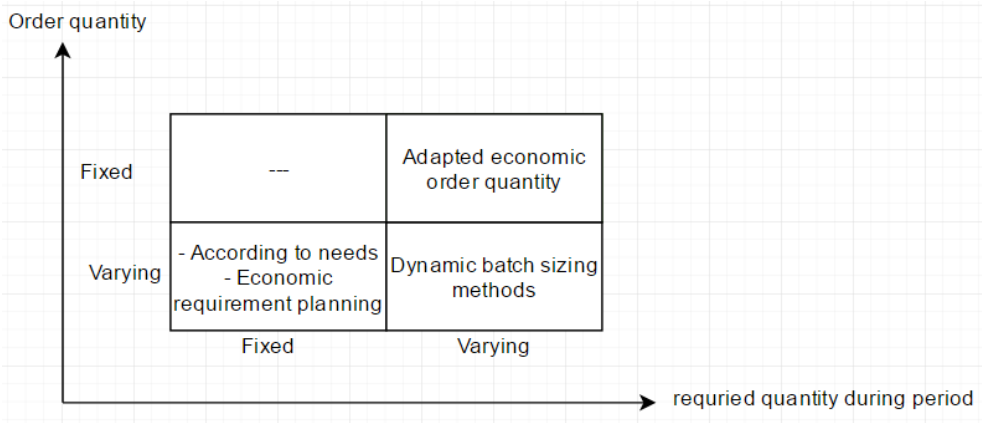

Figure 3. Evaluation matrix for estimating batch size method adapted from Jonsson and Mattsson (2011)

In many cases, companies have to rely on the order quantity specified by the supplier. The supplier usually requires a preferred minimum quantity from the buyer based on the manufacturing process, packaging or transport of the goods. Even if the buyer at a company want to buy a specific quantity it might not be possible or much more expensive due to the restrictions and the low flexibility provided by the supplier. In some cases, on the other hand, the supplier wants a plan from the buyer to make sure they will keep the buyer as a customer and can in turn be more flexible. The size of the company and how important the buyer is for the supplier and their relation makes the flexibility in order quantities and the ability to influence the supplier different (Benton, 2005)

Even if the suppliers have a preferred minimum quantity, companies continuously need to plan for the optimal inventory levels out from the requirements by the supplier but also the size of the warehouse, in order to optimise the costs. The balance where the match between supplies and demand of the items is achieved needs to be on a sustainable level to eliminate the risk of buying the wrong quantity (Mubiry 2015). However, Relph (2015) states that it is important to determine both how much needs to be ordered to match supply with demand but also how much extra is needed to cover for the unexpected demand, late deliveries from suppliers or other unexpected events. When inventory levels exceed the quantity demanded, the inventory

carrying cost increase, which in turn affects the margins and profit (Mubiry, 2015). It is the same for the opposite, where inventory levels below the demanded quantity leads to shortage costs and loss of potential customers. Both of the cases result in a lower profit margin. Actions need to be taken to eliminate the risk of this to happen, by a better inventory management method to reach the optimal inventory levels for the company. The mostly used method for managing the batch size is the Wilson formula (Jonsson and Mattsson, 2011). This formula is built on minimising the different costs included in managing the inventory levels. The most optimal economic order quantity (EOQ) of the items can be calculated as a way to make the planning of the quantity easier and more correct (Mubiry, 2015).

A way to find the optimal order quantity of how many products that should be placed in inventory and sent in each batch is to use the method of economic order quantity (EOQ) by calculating the quantity that minimizes the total inventory holding cost and ordering cost. The basic EOQ model is suitable to use if the demand is known with certainty and is constant over time, no shortages are allowed, order quantity is received all at once and lead time for the receipt of orders is constant. The model is a continuously order cycle system of inventory. When the inventory level is decreasing to the re-order point, a new order will be placed. When deciding upon the most suitable re-order point (ROP) it is according to Relph (2015) important to evaluate:

1. How much and how often to purchase raw material
2. How to protect against variations in supply and demand
3. How long it will take to make/deliver the item

When the order is placed, there is a certain lead time until inventory will be replenished which needs to be considered when calculating the optimal re-order point level. The cycle is continuously repeated for the same order quantity, re-order point as well as for the same lead-time (Relph 2015).

The economic order quantity is the optimal quantity resulting in the minimal carrying cost and ordering cost (Figure 4). These costs act in reverse to each other and the balance between them needs to be considered to reach the optimal level. When the size of order is increasing, fewer orders need to be placed, which lead to a decreased ordering cost, but the average amount of inventory will increase which results in an increased carrying cost. The optimal order quantity is represented by the best combination of these two related costs, resulting in the total cost. The relation between the holding cost and the ordering cost result in the optimal order quantity.

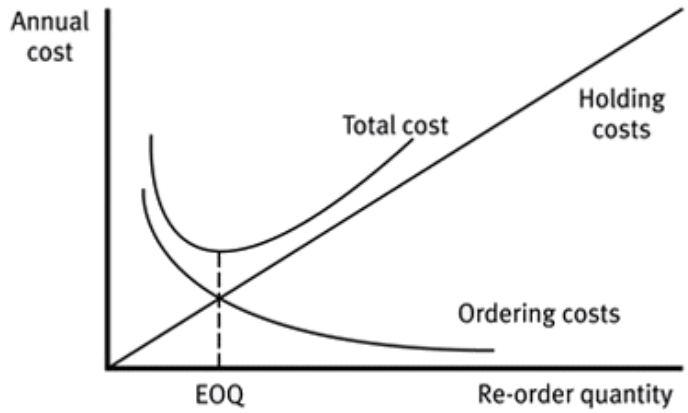

Figure 4. Illustration of EOQ and the total cost (Jonsson and Mattsson, 2003)

As can be seen in Figure 4, the total cost can be calculated out from the ordering cost and the holding cost. These costs result in the total cost:

$$TC = \frac{Q}{2}IC + \frac{D}{Q}S$$

By deriving the total cost formula with respect to the order quantity, the formula for the optimal order quantity can be found:

$$\frac{dTC}{dQ} = \frac{IC}{2} - \frac{D}{Q^2}S = 0$$

$$\frac{IC}{2} = \frac{D}{Q^2}S$$

$$Q = \sqrt{\frac{2DS}{IC}}$$

D= demand during lead time
S= cost for placing an order
I= cost for holding inventory
C= value per stock unit

The lowest level on the total cost curve represents the point where EOQ results in the lowest annual cost. As can be seen in Figure 4, the total cost curve is relatively flat which means that the sum of the incremental costs are not sensitive for order quantities that departs from the optimal value. The same is for the economic order quantity, meaning that a change in the calculated EOQ means relatively small changes in the annual cost. Therefore it can be important to include other factors as well when deciding upon the optimal quantity to order. For this reason it is also acceptable to round of the value to multiple packing quantities to ensure the easiest way of packing a batch or quantity. Sometimes, practical and technical restrictions makes it impossible to follow EOQ properly, when for example the warehouse space is limited, the best before date is limited or when there exists liquidity restrictions (Jonsson and Mattsson, 2011)

Some other common restrictions when planning for the optimal order quantity could for instance be volume restrictions meaning that the supplier requires the purchaser to order a specific amount each time, which could be to fill up a container before shipping or other volume restrictions that result in free shipping fees or other bonuses related to the purchased volume (Jonsson and Mattsson 2011).

Estimation of ordering costs
When analysing what is included in the ordering cost, Jonsson and Mattsson (2011) explains some factors that could be considered to be able to find an estimated value of these costs. Typical cost parameters that usually are included in the order cost are summarized in Table 1 (Jonsson and Mattsson 2011).

According to Mattsson (2003) all cost parameters are not considered as important in all purchase situations. New orders include for instance negotiation costs, and especially cost parameter 1-3 in Table 1. These can be eliminated from repetitive orders. Depending on the characteristics of a company's order system and the way of placing orders, the order cost will differ. If a company is managing a lot of low value items manufactured by indirect material, a simplified choice of supplier can be applied which eliminate cost number 1 and 2 in Table 1.
The quality cost control is only included when batches are checked from time to time or when a random check of items is performed. Overall control of deliveries is not assumed to be considered as an ordering cost. External transport costs are sometimes included in the price of an item, and should in those cases not be seen as an ordering cost. It is common that there are restrictions of transport costs depending on the order quantity, and therefore the external transport cost is not considered as an ordering cost. A common way of calculating the order cost is to estimate an average value calculated per item of the total order cost. All purchase- and goods receiving costs are summarised as one order cost, and this number is divided by the total amount of orders during the period, (Mattsson, 2003).

Estimation of inventory handling costs
Inventory holding costs are all costs that occur as soon as an item is placed in inventory. Holding costs increase when inventory levels increase. Holding costs include both fixed and variable costs. This parameter is used to determine the economic order quantity of inventory holding items. Common costs included in the inventory holding cost are summarized in Table 1 (Jonsson & Mattsson 2011).

The capital cost of an inventory is represented by the imputed interest for the tied up capital in inventory. This cost is variable and increase linear with the size of capital. Managers usually set this factor. Cost 6 and 7 as well as 8, 9 and 10 in Table 1 are to some extend variable but the rest are in the long run assumed to be fixed. These are not usually included in the inventory incremental cost calculation. Administrative and handling costs are not affected by the quantities stored in inventory and are not represented by an incremental cost in this case.
The costs in Table 1 are often represented as factors, the so-called inventory incremental costs in percentage of the tied up capital. This inventory incremental cost are assumed to be linear with the size of the warehouse, and the inventory incremental factor of an item is calculated as the inventory incremental factor multiplied by the inventory level at the time the calculation is performed.

Table 1. Examples of common ordering- and handling cost parameters (Jonsson & Mattsson 2011)

	Handling costs	**Ordering costs**
1	Capital costs	Quotation request
2	Costs of rent	Negotiation with suppliers
3	Cost of shelves	Choice of supplier
4	Cost of handling equipment	Purchase request
5	Handling costs	Purchase order handling
6	Insurance	Control of orders

7	Expenses for depreciation	External transports
8	Cash expenses	Receiving of goods
9	Cost of waste	Check of arrival
10	Inventory costs	Placing in stock
11	Administrative costs	Receipt reporting
12	Computer handling costs	Internal transports
13	Employee costs	Payment
14	-	Invoice control

2.3.2 Service level

When calculating the EOQ for a certain situation, practical aspects need to be considered as well. The reason for this is mainly to avoid issues related to unforeseen occasions that are excluded from the theoretical part when calculating the EOQ. By using the economic quantity as a base, it can work as a direction but it is important to add other aspects to be able to keep a high service level on the items. The service level is according to Jonsson and Mattsson (2011) the ability to directly deliver the item from stock. It is the probability that a customer order can be delivered according to the customers' requirements. Companies mainly for two reasons use service level: both as a variable of effectiveness to be able to measure the performance of the inventory with the aim of following up the measured parameter and it can also be used as a planning target and a parameter for managing the safety stock level. The two approaches of defining service level are sometimes replicable to each other. The planning targets do not always match the dimensioning target and vice versa. Therefore it is crucial to include theoretical models, such as calculating the economic re-order point, and in addition include the dimensioning target with practical models discussed with the managers of the company to make sure the overall target of the company is fulfilled (Jonsson and Mattsson 2011).

The two most common definitions of a dimensioning target are as follows (Jonsson and Mattsson 2011):

- The possibility to deliver from stock during an inventory cycle (Serv1)
- Part of the demand that can be delivered directly from stock (Serv2)

The definition of an inventory cycle is the time from one inventory replacement until the next. There must be a balance between backlog and keeping too many items in inventory, since both results in high costs. The balance here set the service level according to the importance of the item and its value. Service level is by the formula defined as the possibility to deliver directly from stock during an inventory cycle, and is as follows (Mattsson 2003):

$$Service\ level\ in\ percent = \frac{1 - number\ of\ inventory\ cycles\ with\ defects}{total\ number\ of\ invnetory\ cycles} * 100$$

This means the most valuable items need to have a higher service level. The formula also indicates that the items with high turnover rate with many deliveries result in more shortage

situations, compared to items with low turnover rate if the same service level is applied. If the service level is 90%, it means that for an item refilled once a year is shortage once in ten years, but an item that is replenished 20 times a year will be shortage twice a year. Therefore, items with a high turnover rate with short inventory cycles need to have a higher service level than items with low inventory turnover rate (Mattsson, 2003).

2.3.3 Safety stock and re order point

In many industries, companies still use quite simplified inventory management models. According to Jonsson and Mattsson (2015) a study by PLAN 2015 showed that only 30% of the companies examined used any form of calculations that took into account the cost consequences when deciding about order quantities. The remaining 70% estimated the quantities out from intuition, experience, tradition or other form of subjective estimations. The conditions are the same when it comes to deciding about safety stock levels where 40% of the companies evaluated updated their order quantity levels only once a year or even less frequently. Only 33% of the companies in the study decided their safety stock levels out from a desirable delivery capability in form of service level. The remaining 67% decided safety stock level based on intuition and experiential judgments without any connection to desirable delivery capability, lead-times or shifts in demand (Mattsson, 2008).

Order quantities and safety stocks are often estimated in proportion to the size of the demand. These sort of methods are called proportionality methods, and the outcome of using such methods is results which more or less departs from the results that would have been the outcome if more qualified methods where used (Mattsson, 2008).

With better and more effective methods for inventory management, processes and steering systems, costs, tied up capital and delivery capability can be influenced and create competitive advantages. Almost all companies are using some sort of business software and the most part of these programs are also supporting various kinds of inventory management methods. In contrast to the opportunities that obviously exist among companies, very few are using mathematical methods or algorithms for deciding for instance safety stock levels. For many companies the safety stock levels and order quantities are updated only one time per year (Mattsson, 2008).

When calculating the safety stock level, the service level factor can differ depending on the scope of the calculation. The factor can either be Serv1 or Serv2 and the definitions are as follows.

- Serv1 is the possibility of no shortage during one inventory cycle
- Serv2 is the amount of orders that can be delivered directly from inventory (inventory availability)

If a company reaches Serv1 with 90%, the demand can be satisfied from the inventory at 90% of the inventory cycles. During the remaining 10% of the inventory cycles there will be a shortage of items, but only in a small part of the demand in the end of each refilling cycle. Thus, the availability of items will therefore be higher than 90%. Serv1 does not indicate in which extent the shortage will be, only the possibility that it will occur (Aronsson et. al., 2006; Meindl and Chopra, 2007).

The formula used for calculating safety stock with regard to Serv1 definition requires that there is no uncertainty in lead-time from the supplier since it only takes uncertainty in demand into

consideration. When safety stock is decided on the ground of Serv1, the demands standard deviation is multiplied during the lead-time (**σ)** with the safety factor (*k)*:

$$SS = K\sigma_d$$

SS= safety stock
K= safety factor (see Table 2)
$\boldsymbol{\sigma}_d$ = Standard deviation in demand per period

This method gives more correct numbers of inventory levels out of an uncertainty in demand perspective. The method although implies that the lead-time from supplier will always be the same, and no uncertainties will occur, which may not always be the case.

The choice of safety factor depends on the desired probability for shortage not to occur during lead-time (Meindl and Chopra, 2007). In Table 2, some examples of various service levels shows what the safety factor will be, and that factor will then be used in the formula to create a robust safety stock.

Table 2. Service level in relation to safety factor (Mattsson and Jonsson, 2003).

Service level	Safety factor (*k)*
50%	0,00
90%	1,28
95%	1,65
98%	2,05
99%	2,33

With regards to this, the dimension of the safety stock is a result from the desired safety factor and the current uncertainty in lead-time and/or demand.

Serv2 can be defined as the amount of orders where the demand for each product can be met direct from stock. The term expresses the probability that a product is in stock and is thus a measurement of stock availability. An advantage of the Serv2 method compared to Serv1 is that it expresses how many items that cannot be delivered directly from the inventory at shortage situations. The risk for shortage occurs every time the inventory is about to run out of items, therefore risk situation will occur more often if there is a reduction of order quantities. If there is a decided upon service level, or inventory availability, the quantity of the expected inventory shortage is calculated:

$$F(k) = \frac{(1 - Serv2)Q}{\sigma}$$

F (k)= the service level where each value corresponds to the value of the safety factor *k* as can be founded in Table 2
Q= order quantity
σ = Standard deviation of demand during lead-time.

The volume of the safety stock is then calculated in the same way as with Serv1. Thus, by multiplying the service function with the standard deviation in demand during lead-time.

The re-order point is calculated by taking the demand during the specific lead-time for a product and the safety stock that is calculated in beforehand. By using this formula, one ensures there are products in stock during the time it takes for new products to be delivered.

$$ROP = SS + DL$$

ROP= re-order point
SS= safety stock
DL= demand during a period

2.4 Multi-channel approach to categorise items

When managing the service level of different products, it is common to use a categorisation based on the volume value where the products requiring a high service level are prioritised for the company (Mattsson, 2003). Managing the requirements of items is an important and challenging task where costs can be saved if making a detailed differentiation of the products hold in inventory (Boylan, 2008). An operational issue brought up is the management of parts through categorisation of the relevant stock units (SKU's) in order to facilitate the decisions in line with the forecast and control of stock levels. Categorisation of products makes it possible for managers to focus on the most important SKUs. By classifying the demand of different products the control of stock levels can be improved which in turn improves the service level and reduce costs (Boylan, 2008).

In organisations, the demand for different products is highly varied with different cost levels, service requirements and variations in demand (Boylan, 2008). By segmenting the parts, a higher service level can be reached for some parts more than others (Naylor, 1996). The criticality of the items can be divided into low medium and high, reflecting how the potential unavailability affects the costs of the items, quality of processes etc. (Dekker and Bayindir, 2004).

A technique to use for focusing on the most important items is Pareto's law, which is defined by Suresh (2013) as: "80% of the result comes from 20% of the efforts". Using the categorisation from Pareto's law, all SKUs are listed in an order from demand frequency, volumes or value (Silver et al. 1998). Relevant categories are specified for all items. The most common segmentation is to split the items into A, B and C but it can be extended and more classes can be introduced if needed. The number of classes is often limited to six (Graham, 1987).

According to Syntetos (2009) the most common categorisation of items is the value-based approach. The items with highest value require a higher service level and are ranked as A-items. The traditional ABC categorisation can be accomplished by a multi criteria approach meaning that the items are categorised from different rates. It can also be classified as a multi-criteria methodology by using multiple ways of categorisation, e. g a two-way classification by both cost and demand volume (or cost and frequency). This kind of categorisation allows more flexibility when developing service levels by category in order to include different aspects and achieve the overall targets at minimum costs. Only using one category might exclude other views which results in a wage result. A disadvantage of using a multi criteria approach could

be that the classification system becomes more difficult to manage and optimisz. According to Nielsen (2007), a conducted multi criteria ABC analysis with the approach of both resources such as capacity, similarity and materials perspective (volume, cost, seasonality) is crucial for providing a robust method.

The traditional way of using the ABC analysis has been around for a long time, and is widely used in warehousing industries. Generally, the A B and C items have mainly over the years been based on only one criterion, just as it was meant to be when Pareto lounged the method (Flores and Whybark, 1987). The traditional way of using the ABC classification can sometimes be dangerous to use, since it may be misguiding on how to treat different products, since it only shows the criterion based on one aspect (Flores et al., 1992). For inventory items, the most used criteria has often been based on the volume value, which is the value multiplied with annual usage. But for many items, other criterion may be representing important consideration for management. Some of these other criterions may even weight more heavily than the volume value.

To get a major exchange or get the most out of the classification, it is important to choose the criterion for the ABC-classification with great care and not choose on routine. The starting point when choosing the criterions is to choose criterions, which have a cause/effect-connection in line with what the company wants to make more efficient or improve. Something that is often used and mentioned in literature is ABC-classification out from the frequency a product is picked/ordered. This can, for example, give an indication of whether it is used evenly over a period, or if it has large peaks and lows, and along with such information create an ABC-classification (Mattsson, 2003).

It is important to consider different rules for managing each classification, which could for instance be which of the criterions that are more important than others to consider. If this is done correctly companies can improve inventory reduction and improvements in meeting delivery schedules. Often the criterion used is input that concerns costs, but it has been highlighted in resent literature that non-cost criteria such as lead-time, obsolesce, availability, sustainability and criticality could also be important inputs for the management of inventories (Flores and Whybark, 1987). The lead-time can be of great importance when planning for inventory, for instance, a C-product seen from a sales perspective may need more inventory space than a A-product with a short lead-time. If not lead-time would be counted for, instead only the cost-value, the C product would be given much less storage space, which could lead to stock-out problems. Focusing on just a measurable cost may also under-emphasize low annual cost items, which could also be of great importance for the company to have in stock. To only have this one guidance of your items, it may lead the firm to mismanage its inventory assets (Flores et al. 1992). The non-cost criterion criticality is considered important, due to the fact that it includes the severity of the impact of running out of products, how quickly the item could be purchased and whether there could be an available substitute for the product. It is although important to keep in mind that the number of ABC-combinations needs to be kept down, since each combination may need different management policies, and too many may therefore be complex to use. Therefore, to keep the number of inventory management policies to a workable few, the number of combinations needs to be kept down and be agreed upon between different departments (Flores and Whybark, 1987).

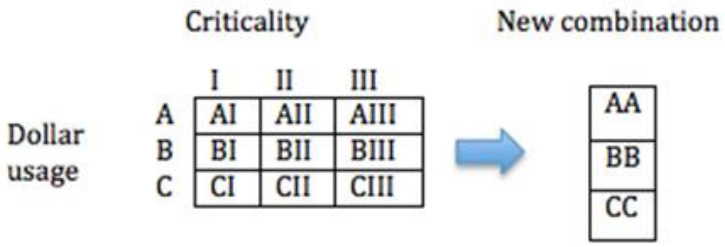

Figure 5. Two criterions ABC with new classification, adapted from Flores and Whybark (1987).

To create the combinations of different categories, companies can use several different approaches. In the study conducted by Flores and Whybark (1987), two main approaches were used and compared with each other. The main different between the two approaches were that only one of them used management policies. Both starts off with an initial item classification out from a large number of inventory data. Out from this, ABC categorisation is made on the criterion that is chosen, for instance the so often used dollar-usage value. Management after this review the classification to determine if it should be reclassified or if its looks ok as it is. If managers chose to reclassify the categorization, an additional categorization is made which will be compared to the first one. The manager's categorization is made upon other criterion that the one first made. The additional one is made out from criticality. The criticality step is made to see how critical the items are for the firm, out of the manager's perspective, and not from the dollar usage perspective.

Managers were in the study asked to take into account all factors that they felt defined a critical item. Such factors could include: impact of an outage, ease of replacement, and so on. If an item were to be seen as a critical item, it was to be classified as I and if clearly non-critical, classified as III. The first classification is after that compared to the managers classification, and a new, combined, classification is made where more criterion than only dollar-usage is used. When it is like in this example with two different criterions, it's an entry for every combination, which means that nine different combinations can be found. For each of these, different management policies could be constructed, which makes it to complex, the combinations need to be reduced. The new classification combinations can be conducted as can be seen in Figure 1 (Flores and Whybark, 1987).

In the example seen in Figure 5, two different criterions (A, B, C and I, II, III) have created three new criterions AA, BB and CC. In this new categorization more inputs than in previous categorizations have been used. Instead of creating nine different categorizations, as can be seen to be the outcome on the left hand in the Figure 5 (AI, AII, ...CIII) three new categorises have been created. By applying this method, the categorization will be more robust compared to the previous method were only one criterion stood as the input (Flores and Whybark, 1987).

Inventory management policy parameters for the manufacturing company			
Decision/category	AA	BB	CC
Counting frequency	Monthly	Every 6 month	Yearly
Order quantity	Small for costly items	Medium EOQ based	Large quantities
Safety stock	Medium for critical items	Large for critical items	Low or none
Reclassify review	Every 6 month	Every 6 month	Yearly

Figure 6. Example of management principles (Flores and Whybark, 1987)

According to Flores and Whybark (1987) there are two different ways of managing the categories. Companies can either use so called management principles or guidelines for how different categories should be managed. Guidelines are often more loose suggestions of how to deal with the categorisations. For instance AA products should be "closer managed or be given more management attention than other products". Management policies on the other hand should be designed to cover several aspects of concern to the inventory managers and to make specific what "closer management or more management attention" means. An example over how management principles could look like is obtained from Figure 6. The policies are developed differently depending on which company it is created to. By focusing on more than one area, companies can create a system of classification which is very useful and powerful since it allows management to focus attention on the areas of products with the highest payoffs, and not just on products that they sell large quantities of. It also gives more input and creates a robustness, which cannot be found in the same extent if only one criterion as an input is used (Flores et al., 1992).

2.5 Planning demand uncertainty through customer differentiation

In recent years, it has become an important topic both for academics and practitioners on how to manage customer relationships. Different customers have different economic value to the company, and should therefore be handled in slightly different ways. Managing customers in different ways are beneficial but at the same time companies need to keep in mind that more relationship building is not always better, the important part is to build a strong relationship for the right customers (Reniartz et al., 2004). Companies need to consider customer behaviour and profitability in order to successfully manage individual customer relationships. Except from profits, other aspect could also be included on how companies view their customers, such as the connection to the focal company, how close one are to the customer and how knowledgeable the customer is about the market, (Gordon, 2003).

Ulaga and Eggert (2006) mean that it can be costly for companies to have the same service for all of their customers. To differentiate the service is good for more reasons than just the financial one. By having a special service for the most important customers, one can create a situation where the firm can gain a key supplier status with some specific customers, and thus make the customer more dependent on that specific supplier. The opposite situation may be that companies find themselves in situations of instead becoming a backup supplier. In today's business environment, independently on business area, it becomes more about differentiate in other ways than solely product and price, but instead differentiate through value creation for the customer. The value creation could for instance be a new way of creating an additional service that other companies may not accommodate yet (Ulaga and Eggert, 2006).

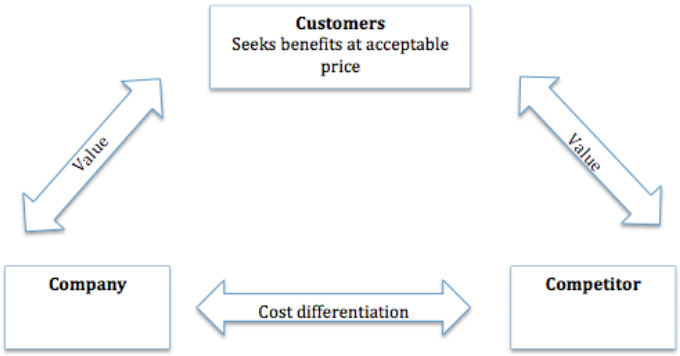

Figure 7. Value creation through cost differentiation (Christopher, 2005)

By creating value for the customer, companies can create a competitive advantage. Figure 7 shows that one way of creating value for a company can be through cost differentiation, which can create a competitive advantage. But price actually shows the weakest potential for differentiation (Ulaga and Eggert, 2006). The source of competitive advantage is found in the way an organisation is able to differentiate themselves from their competitors, in the eyes of their customers, to be able to increase their profit. If one considers the very basis of success, it can either be derived from a cost advantage or a value advantage. The cost advantage gives a lower cost for the specific product and the value advantage delivers a product or service, which offers a different service compared to other companies (Christopher, 2005). This is an opinion shared by Ulaga and Eggert (2006) who states that there are two way of viewing business relationships, either the differentiation must contribute to customer value by providing benefits to the customer or by lowering their costs. Creating superior customer value can be the key to a company's long-term survival and success.

Nowadays, customers have increasingly moved away from using several different suppliers and instead moved towards the building of long-term relationships with selected key suppliers instead. As has previously been mentioned, it is costly for suppliers to have the same service for all customers, but it is also costly for customers to use many different suppliers, therefore the trend has moved towards using fewer suppliers instead. As a consequence of this it becomes of utter importance for suppliers to differentiate themselves to increase the customer's attention and awareness Ulaga and Eggert, 2006).

Service differentiation

Supply chain costs are often high, which has pointed the focus for many companies towards improving their supply chains. According to Attaran and Attaran (2007) both distributers, retailers and manufacturers had identified that supply chain cost reduction was a critical issue that had to be addressed, which proves that it is of great importance for many to decrease their supply chain related costs in some way. Also the lack of collaborative planning has a significant impact on how companies supply chains is performing (Attaran and Attaran, 2007).

One way that has previous been brought up by Ulaga and Eggert (2006) is to differentiate customers based on service. This means to offer them a service that other customers do not receive, as well as other competitors may not offer (Ulaga and Eggert, 2006). It becomes more and more important for companies to find different ways of creating value for the end customer, and to continuously improve their supply chains. This is due to the fact that competition between companies are getting tougher, due to globalization and frequently changing demand pattern in ways that companies have not seen before. As a consequence of this, supply chains

tend to become more complex. Many initiatives have been used over the years for improving overall performance of supply chains and to increase customer value for companies in different sizes (Mishra and Chan, 2012). Two examples of these are:

- Vendor managed inventory
- Collaborative planning, forecasting and replenishment

The aim of using such methods is partly to improve the result for the customer and to increase value in the supply chain by working in more efficient ways (Mishra and Chan, 2012).

Vendor management inventory
Vendor management inventory (VMI) is one way to simplify the supply chain planning processes and is especially useful for small and medium sized companies that can take advantages of a better cooperation with customers. The principle of VMI is basically that the responsibility of stock management is handed over to the supplier instead of the customer. The benefits of this will be that the supplier can easily control and adjust the distribution planning to changes in customer demand. A way of decreasing the complexity related to this initiative is to use so called online suppliers who do not receive purchase orders, but instead are responsible for delivering products according to the needs of the retailer. The supplier is then able to get access to the information system and view the stock levels and future requirements from customers, (Hvolby 2002).

Collaborative planning forecasting and replenishment
One large problem in the context of making supply chains more integrated is the lack of visibility and the information of true customer demand. Collaborative planning, forecasting and replenishment (CPFR) is a strategy that promises to overcome such barriers by having a more integrated supply chain, and seeks through joint planning, joint decision making, joint forecast development and a new replenishment method which looks like the VMI-method, benefits of actual supply chain integration (Barratt and Oliviera, 2001). By using CPFR, companies seek the joint management of inventory by having a joint visibility and replenishment of products throughout the supply chain (Seifert, 2003). Instead of waiting for orders to come in, the suppliers themselves replenish their customer's inventories when they detect that the stock levels are too low, (Holmström et. al, 2002).

The underlying idea with collaborative planning is the idea of sharing information between supply chain partners, to reach common goals. The method is based on trust between the members involved in the supply chain. The trust-relationship means sharing of strategic information in order to optimise the overall supply chain results. By working in such way, one makes the supply chain demand driven instead, with the goal creating more value to the end-customer. The soul in this method is information sharing. Information sharing is one of the most important strategies for companies to increase their supply chain competitiveness. By working in such ways, it eliminates waste and can lower supply chain costs at the same time as it also ensures higher customer satisfaction, improves fill rates and delivery loyalty (Ulaga and Eggert, 2006. The usage of such method leads to a more open and transparent supply chain which can increase the efficiency of the chain as a whole, (Seifert, 2003).

The reason why many companies use CPFR is due to the fact that the accuracy of the forecast (demand, order, sales) can be improved when customer and supplier together plan for the forecast. Buyer and sales people possess different knowledge and have different information and by cooperating more deeply, they can create a situation where it is easier to satisfy their

customer (Attaran and Attaran, 2007). Another advantage of using a method like CPFR is that suppliers may not always be in possession of their customer's point of sales (POS), which in many situations can be very powerful to be able to use. By implementing CPFR as a method, one part is for the supplier to be in possession of the point of sales data from the customer. This due to the fact that forecasts are created jointly and also since the supplier need to have such data to be able to optimize the replenishment amount for the customer. By using such information, a more accurate sales forecast can be made by the supplier since they will see the actual demand and not only the amount purchased by the customer. Customers often make their POS-data available to their suppliers who consolidate this information as a monthly pattern in comparison with the previous year and, based on that, try to predict how the upcoming moth of sales will look like (Barratt and Oliviera, 2001). Holmström et al (2002) opinions are consistent with Barratt and Oliviera (2011) and states that using POS enables you to find more accurate scaling rules when purchasing new items and making a new forecast, since this information is seen to show the "true" demand instead of using just previous sales orders to customers.

The method aims at improving such problems as holding high inventory levels to guarantee products availability, problems related to multiple forecast developed inside the same company (marketing, financing, purchasing and logistics) and the influence of promotions in the creation of the sales forecast, (Barratt and Oliviera, 2001). Information such as POS data, promotion schedules and inventory data is necessary for the customers to share to be able to decrease lead-times and create integration between forecasting and the replenishment process. By using CPFR, demand planning and supply planning are coordinated, which is to be seen as a large advance and seen as an advantage when using the method. Some of the benefits by using CPFR according to Barratt and Oliviera (2001) are:

- Reduced costs
- More receiver friendly goods
- Daily download of information
- Accuracy in information
- Increased customer service
- Faster inventory turns
- Real-time information
- Reduced inventory holdings
- Reduced over stocks

The planning phase when implementing CPFR in your business is the key for it to be used in a successful way. One of the most important aspects for it to work optimal is to have a software package that suits all members. For partners to implement CPFR in a way that creates success, the first step is to develop an adequate environment. This environment is mainly based on two concepts: trust and technology. The process of creating trust between the partners can follow these four different steps:

Define single point of contract for each trading partner. This ensures the information is neither lost or fades when it flows between the trading partners.

Define the agenda for the collaboration. By doing so, one stabilises the collaborative goals over a longer time and define common goals for the all parts to strive for.

Ensure continuous sharing of information. The need to have continuous information sharing is very important for CPFR to work well.

Trust development. The trust-based relationship will not come immediately, it will be built up over time. During this time, small barriers will be removed from the path of the CPFR process, which will bring confidence to the partners of the collaboration and their long-term vision is solid.

The main barriers of the implementation phase of CPFR are according to Barrett and Oliviera (2001) those factors that complicate the visibility and information flow in the supply chain between the partners. Problems that may result from poor visibility and lack of information sharing are that inventory levels may be inaccurate and point of sales data may not be available. There may also in some situations be difficult to convince customers to start working more with forecasts if this has not been done before. People are often relatively comfortable and have sometimes hard to see how a new way of working can improve their current situation. Especially if it means they have to change how business is carried out today (Holmström et. al, 2002). These are other areas which Barrett and Oliviera (2001) have highlighted as barriers in the implementation phase, thus areas which companies should put extra focus on:

- Ineffective replenishment in response to demand fluctuations
- Ineffective planning using visibility of POS customer demand
- Trust and sharing by opponents
- Difficulties to manage sales and order forecasts
- No shared targets, optimum service levels among stores
- Sufficient information technology is a major need for the forecasting process
- Promotions and new items events are not jointly planned

It's important with top management involvement, trust between collaboration partners, continuous measurement of performance, innovative IT strategy, up to date cost accounting methods, emphasis on customer satisfaction, flexible organization structural and proper staff training. If the implementation and practice goes well, the benefits of CPFR could be: enhanced relationship between partners, increased sales revenues, improved product offerings, reliable and accurate forecasts and reduction in inventories (Attaran and Attaran, 2007).

3. Methodology

The following section describes the method used for the study. It starts by explaining the research method followed by the literature review. It further on describes how the data was collected and the method used for analysing the data. The last section includes a discussion of the reliability and validity of the case study.

3.1 Research strategy

This study is a single case study performed from a distributor's perspective, storing mainly tires and rims. The aim during the study has been to answer the research questions that were set in the initial stage of the project. According to Bryman and Bell (2011) there are two different approaches to a research strategy, a quantitative research strategy and a qualitative. The purpose of a quantitative study is to generalize theories about an environment from findings out of samples in that specific environment (Bryman and Bell, 2011). The use of quantitative data is very effective when the purpose is to examine the frequency and space, which means how often and how much of a phenomenon that is studied (Esaiasson et al., 2007). To achieve studies like this, the data collected must be quantifiable, i.e. the data should consist of numbers. The aim of this approach is to get a deeper insight and understanding of the area studied. Additional reasons for using this strategy are to generate measurable data and reinforce hypotheses. It is also used to control alternative methods and risks and to be able to get a broad view of the findings (Bryman and Bell, 2011). The other approach is the qualitative approach. Application areas where it may be beneficial to use the method is when the purpose is to describe and interpret experiences and perceptions of individuals. The collection of such data can be through literature or archival data and case analyses. The quantitative strategy is used to examine and understand problems that are perceived by groups or individuals. A written report based on a qualitative research is more concerned with words and the interpretation of the environment rather than numbers and statistics. By having several different methods, one can prevent the issue of only relying on one single data source (Bryman and Bell, 2011).

Creswell (2014) states that in most cases, strategies are not usually entirely quantitative or qualitative, but they are often a combination of the two approaches called mixed method research. A method like the mixed method combines a theoretical framework along with assumptions that can provide a further understanding of the specific research, in contrast to if only using one of the extremes alone.

The analysis of this study has been both quantitative and qualitative. This approach was used since the purpose was to find parts in their supply chain that could be improved. Therefore both interviews and interpretation of numerical data lied as a ground for examining where in the supply chain the employees of the company thought they had the largest problems, but also out from numerical data to interpret where they had the best possibilities for improvement. By using several sources of information, it was also considered to build a greater robustness of the findings and create a situation where the best possible suggestions could be obtained. The empirical findings in this study was made mostly out of qualitative interviews with employees from the case company and from interviews with customers. The interviews and the interpretation of quantitative data was qualitative analysed by letting the respondents read and approve the empirical part of the project, this to ensure that the authors had understood the information correctly. The theoretical framework worked as a foundation of knowledge of the subject concerning supply chain costs and optimization of inventory management but also for data collection and for the structuring of interviews.

3.1.1 Three phases of the paper

Dubois and Gadde (2008) argues that the reason for conducting research studies is to combine the empirical world with theory, and to continuously confront the theory with the empirical world. The process for the study of the case company has been carried out in three different phases, as can be seen in Figure 8. The three phases were conducted in parallel throughout the study. The literature review and gathering of empirical data was an iterative process, made over a long time during the project. The different phases are presented to develop an understanding for the reader how the project has been carried out and also to show which methods that have been focused on during different phases of the project.

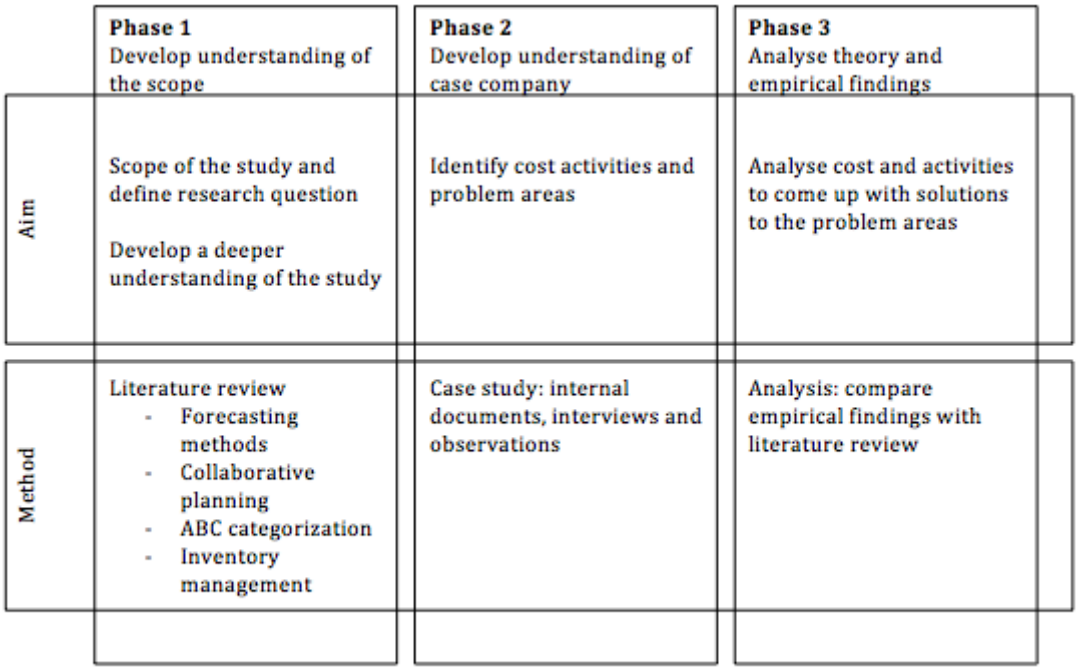

Figure 8. Three phase method used in the study.

The first phase was used to be able to get a better understanding of the specific area, which later would be examined. This was mainly done through a literature review where predominantly literature about demand management, inventory management and how to find unnecessary costs in supply chains, could be found. The second phase focused on developing a better understanding of the situation of the case company and which problems they were facing. This by analysing data that was given by the company and through interviews with employees and some of their larger customers. This information was later used in the empirical part of the paper. In the third, and last phase of the paper, the information gathered from the empirical part and from the literature review was combined to be able to draw conclusions and present possible improvements and changes.

3.2 Literature review

To fulfil the purpose of this study, a significant amount of relevant data needed to be gathered. This to be able to come up with suggestions and improvements, but also to generate a deeper understanding of the field of study. The information from literature was mainly received from literature searches in Chalmers library database and from Google Scholar. The database summon was reached through lib.chalmers.se, a database with access to scientific articles published in a variety of different journals. Some of the key-words most used in the search for

relevant literature were “forecast methods”, “collaborative planning”, “multi criteria approach for categorisation” and “inventory management”.

The literature review of this paper started with a holistic view and description of the area studied, how and why unnecessary costs would be identified. The theoretical review was narrowed down to go deeper into parts chosen to be focused on in this study. This approach was used since it gave the reader a broader understanding of the specific problem areas highlighted during this project.

3.3 Data collection

The collecting of data stood for a substantial part of the study. Information about the company and its operations were in the initial phase low, therefore a large amount of time was put on understanding the situation and how their operations worked. This data was collected through interviews and numerical data obtained from Amring’s ERP system Visma. The interviews that have been conducted with managers at case company and from several different customers to the case company in the area of Gothenburg. The information from interviews have been very valuable not only in the sense of gathering knowledge for where they have problems in their supply chain, but also in order to be able to integrate with employees to find underlying reasons for why problems may occur.

The empirical data was separated between secondary data and primary data. Primary data is data obtained by the authors themselves whereas data collected from previous studies or other sources not obtained by the authors is categorized as secondary data (Denscombe, 2010). Primary data was obtained through interviews with employees and customers and secondary data was obtained through internal documents and from previous benchmarking. In addition to the empirical data, a literature review has been carried out.

Interviews

The majority of the empirical data was collected through semi-structured interviews but some of the interviews have also been unstructured. An unstructured interview is described by Bryman and Bell (2011) as an interview where the respondent only has a list of topics or issues, often called an interview guide that are covered. The main difference between an unstructured interview and the structured interview is that the interview guide does not have to be followed strictly in an unstructured interview. Other questions can therefore occur during the interview session depending on the answers from the respondents. Interviews as a method is powerful for accessing the respondents understanding and experience of a specific question, problem or other issue where it can be of great interest to get information from different views and perspectives (Kvale, 2007).

The majority of the information used in this project comes from interviews with various employees of the company. For almost all interview occasions, interview guides have been used (Appendix A). The interview guides have looked different depending on who has been interviewed. Interviews have been conducted both in groups and with individuals. This since it has sometimes been more effective to have information from one source at a time but at other occasions more efficient to have a group discussion. All questions in the different interview guides used in this study has been open, which means that the respondents have been asked questions that they can elaborate on in their own terms. All interviews were also recorded and notes were taken during each occasion. This due to the fact that it eliminated the risks of missing important information for the study and also to collect as much data as possible.

Interviews with the case company

In the first part of this project, interviews were held with the sales manager, purchasing manager and logistics manager of the case company. Employees from these different departments were chosen in order to obtain a broad understanding of the situation and that good discussions could be held. From the initial interviews the first problem areas could be identified. The initial interview with all three departments were conducted so that the writers could get a better understanding of current state. As can be seen in Table 3, interviews were conducted separately with all three departments. This to further get an understanding of each specific department's problems. All meetings had follow-up meetings to continuously discuss about current problems and ideas. Interviews with customers were conducted to get a deeper understanding of the supply chain and customer's opinions about the deliveries and how they believed operations could be improved. In the final part of the project, idea meetings were held continuously, to discuss about ideas and other opinions from the writers. The initial interviews were held to understand current state and to identify the strengths and weaknesses. All interviews were open, semi-structured, and face-to-face, at some occasions the questions were also emailed in beforehand. Appendix A shows how the questions to the interviews were formulated to increase the possibility to get the most out of each occasion. According to Rowley (2012), face-to-face meetings are to prefer instead of Internet or by phone, since the interviewer will have the possibility to interpret the respondent's body language and reaction. Unstructured interviews were held at office hours, mainly with their sales manager and the logistics manager.

Table 3. Interview structure

Phase of project	**Involvement from**	**Number of respondents**	**Reason for interview**	**Input to**	**Questionnaire used**
Initial	Sales, purchasing, logistics	3	To obtain a broader understanding of current situation	RQ1	Appendix A Questionnaire 2
During project	Sales, purchasing and logistics separately	1 at each occasion	To get deeper understanding of each separate department and its problems	RQ1	Appendix A Questionnaire 3
During project	Sales purcahsing and logistics separately	1 at each occasion	Follow-up meetings if questions raised during project	RQ1/RQ2	No Questionnaire used
Middle-phase	Customers	3 in total, but held separately	Obtain broader perspective and compare customers information with previous collected information	RQ2	Appendix A Questionnaire 1
Final phase	Sales, purchasing and logistics separately	3	Idea discussions about findings and results	RQ3	No Questionnaire used

Interviews with customers

In the middle part of the project, three different customers were chosen to be interviewed. These specific three were chosen since they represent three quite different customers, and would give

a fairly holistic picture of Amring's customers. The three customers represent three rather different types of businesses, one of the customers mostly targets the premium segment, the second is in close contact to a large auto firm and has a lot of leasing car customers and the third represent sort of a mixture of the two first mentioned, although they do also serve customers demanding slightly odd tires. At the customer meetings, a sales rep from case company was present to facilitate information from the supplier's side as well. Questions were emailed in beforehand and the interviews were semi-structured, to be able to get a broad understanding. The semi-structured method was also used since it is more time-effective compared to unstructured, and at the same time more flexible than the structured method, (Harrell et al, 2009). Interviews with customers were held in order for the researchers to create a holistic picture of the case company's operations, and to get valuable input from the customer side.

Observations
Flick (2006) differs between completely participating observations and completely observations. Participating observations can for instance be participating in meetings, in coffee breaks or in other daily activities that can add further understanding of the situation. By observing people in their normal work environment, it is possible to see parts that may not come up during more formal pre-determined meetings. Observations have been made during this project of how employees behave in their offices, and how work is carried out there. Through observations from office-level, it became easier to understand how the company was cooperating between different departments and in collaboration with each other. By observing, it has also been easier to understand how employees are communicating and such information would have been hard to grasp and understand unless one had not been in place. A guide through the warehouse also increased the understanding of their internal operations.

Internal documents
Chetty (1996) presents documentation as a source of information and as a case study method. The last source of empirical data used in this study was documentation, mainly from internal documents. Yin (2009) presents several different kinds of internal documentation: written reports of events, internal records, personal documents and mass media. The internal documentations used in this project have mainly been from case company's ERP system Visma and excel files. Information from these sources were gathered from the past three years operations, to get an in depth understanding and more easily see patterns.

In 2014 a benchmark study was made by an outside firm for the case company. This study aimed to investigate how the case company's largest competitors performed and what their strengths and weaknesses were in different areas. This result was compared to how the case company carried out their business to examine if there were any possibilities for changes. As is stated by Camp (2013), a benchmark is the search for industry best practices that lead to superior performance. Watson (1993) describes a benchmark as how to rate your company's performance against the world's best. The documents from this benchmark performed in 2014 have been used in this study to further understand the strengths and weaknesses of Amring. The documents have further been used to understand in which way the case company can differentiate its services to their customers.

3.4 Data analysis approach

This chapter has been divided into two parts, where the first part presents the method used for analysing the critical costs and the second part describes the approach of how solutions to the critical costs were identified.

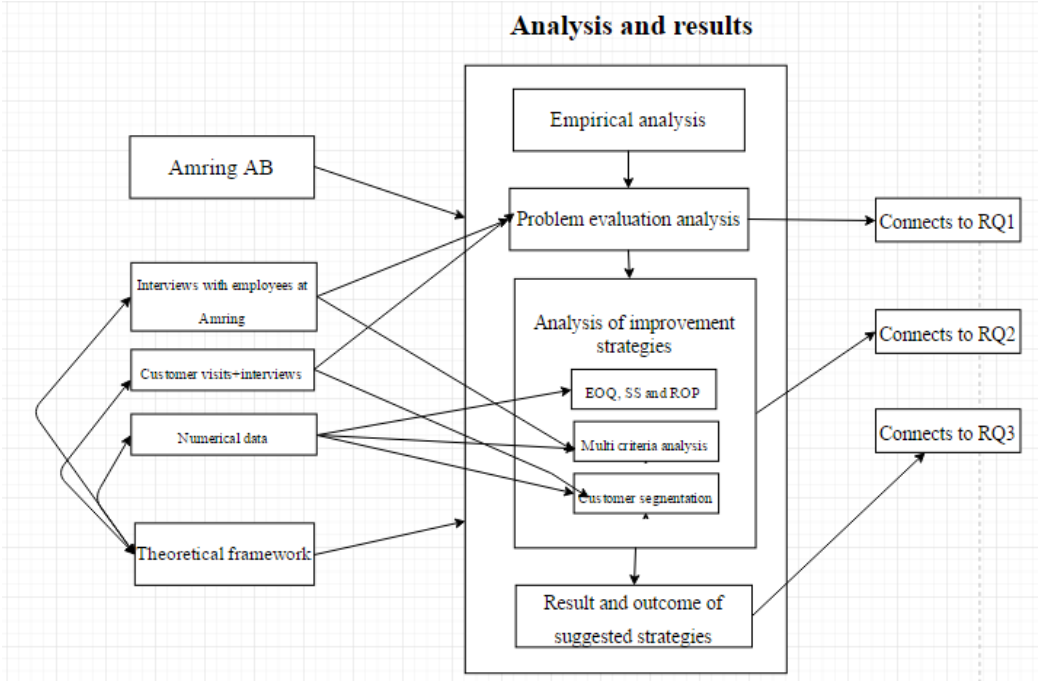

Figure 9. Analysis approach used for the study

The approach used during the analysis of the data is mainly that the iteration among the theoretical framework and empirical findings act as a base for the outcome of the analysis (Figure 9). The continuously input from Amring has also been valuable as input for the final result of the study. The different analysis approaches are all connected to the research questions stated in *1. Introduction,* which the analysis and study aims to conclude in the end.

3.4.1 Method for analysing costs and problem areas in Amring's supply chain

According to Anklesaria (2008) the purpose of a cost breakdown analysis is to identify critical costs in the supply chain. The term critical depends on the evaluation team, sometimes it can be beneficial to purely focus on numbers but in most cases other factors need to be balanced with the costs, when identifying if it is critical or not and if it is significant for the current project. Therefore a method for evaluating the critical costs have been developed (Figure 10), which has been used to identify the problems and solutions to the critical costs.

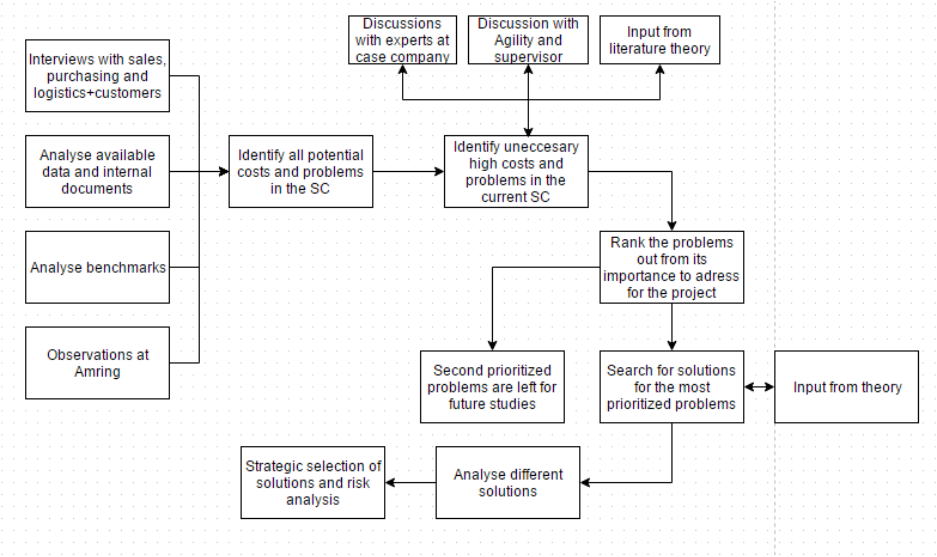

Figure 10. Analysis approach for identifying costs and solutions in Amring's supply chain

The primary aim when analysing the collected data was to identify critical costs and potential solutions to come with conclusions related to the research questions. When identifying the critical costs, a comprehensive analysis was made based on the collected data presented in *3.3 Data collection*. The gathered information from interviews were analysed and compared to benchmarks and numerical data from the ERP system Visma to be able to see if the respondent's opinions were in line with this data. This to be able to draw a robust conclusion of the different cost areas. When focus areas had been identified, a discussion with experts within supply chain from the case company was done to make sure the chosen areas were the ones causing the largest problems for the case company.

To know if the cost is critical enough to break down further, one should base the decision on the following two questions (Anklesaria, 2008):

1. Is the cost relevant for a future cash flow?
2. Is the cost possible to influence by the evaluation team?

When having decided upon selected cost elements that are affecting future cash flows, the focus need to be if the cost is possible to impact or not (Anklesaria, 2008). The evaluation process of the critical costs in this study can be seen in Figure 10.

According to Sehgal (2009) some costs included in the supply chain are wage and because of that hard to measure and define. Anklesaria (2008) means that some costs might be mandated by the government and some are not possible to influence, and those costs should be dropped from further discussions. In cases when costs are possible to influence by the team it is of utter importance to evaluate if they are relevant for the project to impact or if they are beyond the control and out of scope. The wage costs in this case have not been considered as important and are ranked as second order of prioritization (Figure 11) and thus left for further studies. Sehgal (2009) means that it is important to understand all costs included in order to evaluate them and see what drives them.

The critical costs were in addition to the method in Figure 11 accomplished from the conducted literature review. As a first step to find the costs within case company's supply chain, all relevant existing costs were divided into different categories and visualized in a tree diagram. Sehgal (2009) means that when visualizing cost activities it is possible to evaluate them, find existing gaps in the process and also help to continuously improve the costs and efficiency of the operations. The reason for using a tree diagram to visualise the cost areas was since the possibility to rank and balance different option in a strategic way against each other increased and made it easier to get an overview of the cost areas.

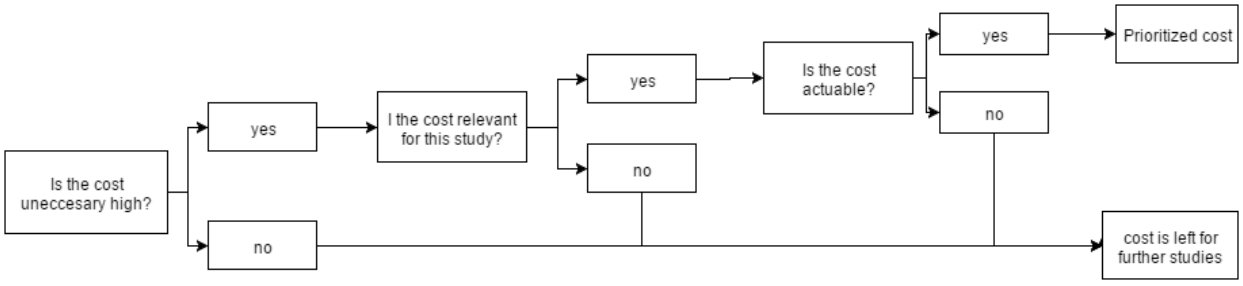

Figure 11. Method for identifying critical costs and problem areas within the supply chain

Sehgal (2009) point to the importance of involving the organisation when analysing the costs. In addition to the method in Figure 10 and literature an evaluation of unnecessary high costs have been done together with representatives from case company and supervisors to make sure no unnecessary high costs have been missed out for further analysis.

It is important to group the costs into categories to provide a deeper understanding of its source and how to measure and optimize the costs in order to be more efficient throughout the supply chain (Sehgal 2009). Akzaheim (2008) means in addition that it is crucial to group costs in order to see which are relevant for the evaluation team. The identified costs were selected and afterwards ranked in accordance to the most relevant cost where there were potentials for the researchers to find relevant solutions to decrease costs the most. The number of selected problem areas were also based on the scope and time limit of the study.

3.4.2 Method for analysing possible solutions to unnecessary high costs

When costs had been identified and analysed, an analysis of the root causes to the high cost was made. This was done to see how the case company was performing in their current state and see if there are potential for reorganisations to decrease cost activities. The analysis was based on the collected data. The literature review was the ground for finding possible solutions to the unnecessary high costs and was matched to the different problem areas related to the problems. From the benchmark with competitors to Amring different solutions of how to solve the problems with high costs came up and were compared to the case company's current situation. In addition, the literature review was also an important source when finding possible solutions to the high costs as well as additional interviews conducted with the logistics manager, purchaser and sales people at Amring. The solutions to the problems were discussed with the project group, consisting of the researchers, supervisors and company reps. Solutions were compared and evaluated to find the most suitable solution for the different problems in the case company's supply chain.

Calculations were made from provided numerical data in form of sales- and purchasing data from Visma and Excel sheets, to prove that the solution eliminated the problem and to show how much savings that potentially could be obtained with the new implementations. Also, other improvement areas which make the process more effective and efficient have also been considered.

The flexibility and responsiveness in supply chains are not always align with low costs. When evaluating the supply chain, measures including other perspectives than low costs need to be included (Seghal 2009). The primary aim was to reduce problems and high costs throughout Amring's supply chain, but it has been of high importance to not decrease other parameters such as service level or increase lead time due to the new solution. A risk evaluation and sensitive analysis have been conducted to make sure the solution will be robust.

3.5 Discussion of reliability and validity of results

The validity of a research is according to Bryman and Bell (2011) if the researchers identifies, measure and observes the areas the study was aimed for. The evaluation is suggested to be divided into internal and external validity, where internal means if the theory matches the empirical data and external means if the outcome of the study can be generalized in other contexts and areas not related to the case study. Reliability is referred to the possibility to repeat the study in other contexts.

According to Bryman and Bell (2011) reliability can be measured from three different aspects: internal reliability, stability and consistency of the observer or researcher. Internal reliability means if measures are connected to other measures and if the result will change if the measure will change. Stability is referred to as if the result will fluctuate or be stable over time. The inter-observer consistency means that there is a possibility for the observer to influence the result, and that the observer do not always come up with the same conclusions from day to day, or influence the result by personal opinions.

The reliability and validity of this study have been evaluated out from the above references. It can be said that there could be a risk that the observer has influenced the result from interviews due to personal experiences. The risk is however small, since both the researchers were attending the interviews and transcribed them together. The possibility of asking the questions again afterwards to the respondents to improve the understanding of the answer reduces the risk of misunderstandings when transcribing the interviews. The same questionnaire was used for the customers, which eliminates the risk of personal opinions and increases the robustness and validity of result. However, the study is based on opinions from respondents from the case company, so the personal aspect is beneficial and of high importance within this study. By asking different respondents from different departments at Amring, the risks for misunderstandings are eliminated. Since a risk analysis has been conducted based on the result, the possibility of getting a more stable result, without fluctuations over time, is increasing which increase the reliability of the study.

Using different data sources can validate the result of the study according to Creswell (2014). In this study, it has been done by using data input from interviews, observations, benchmarks, literature review as well as visits at customers. When conducting interviews, different respondents from sales, purchasing and logistic departments were interviewed to decrease the risk of personal opinions and get a holistic view of the company. In addition, interviews with different customers were held. The result is considered to be more validity if using multiple sources of data (Creswell 2014). When identifying the costs, inputs from different literature approaches have been used which increase the validity of the result. Creswell (2014) also point to the fact that corresponding interviews to complement from the initial interview can be used to increase the validity of the outcome and clarify the meaning. This has been performed by continuously discussions with employees along with the progress of the study in an interactive process. The fact that a mixed approach has been used, including both quantitative and qualitative method also strengthen the robustness and increase the validity of the results.

4. Empirical findings

This section describes the empirical findings from the data collection. It starts by introducing the product range and assortment managed in the warehouse and continues with their current strategies used to manage and control the inventory. A presentation of demand management and planning method is thereafter introduced, and the chapter ends with categorisation of items and a description of their customer base.

4.1 Product range and assortment

Amring is offering budget- and premium brands to their customers. Depending on the choice of material and the quality of the tire, the price differ. A budget brand is usually shipped from and produced in Asia, and in general the quality is poorer and the price is lower on those tires. Premium brands usually come from Europe and Sweden, and the quality is higher which in general results in a higher purchase price. Budget brands are purchased in smaller quantities per batch compared to budget brands shipped from Asia, where larger batches usually are purchased in preseason orders due to the long lead time. During the summer many of the customers prefer to purchase budget tires instead of premium and in the winter it is the other way around. Amring is handling approximately 8000 different article numbers within the warehouse and there are approximately 600 000 items distributed annually from their warehouse.

Amring is trying to tighten their portfolio with tires and rims but are at the same time aiming to have the same range of products available in inventory to their customers, i.e. same selection but fewer of the same sort. As an example of this, the logistics manager mentioned not to have for instance 10-12 different brands but instead move towards having 5-6 brands that can fulfil what the customers need. Amring further strives to improve sales of their premium brand assortment.

4.2 Inventory management

The current turnover rate of the warehouse is approximately 1-2 times a year but the aim is to increase the rate to 4. The low inventory turnover rate has result in high tied up capital which is the major problem for the company. High tied up capital means not only a high risk, but also additional costs of storage and handling. Amring is now trying to improve the turnover rate and make products move faster through their warehouse. The current annual storage cost per item in 2015 can be seen for item 1-4 in Appendix B.

Amring has previously purchased large quantities to be able to deliver on demand orders and reduce the risk of backlog. At the same time, this means that a lot of products are unnecessary tied up in their inventory. Today they are instead trying to purchase smaller quantities to eliminate the risk of high tied up capital in their warehouse. This on the other hand requires orders to be placed more often. In previous years, costs related to inventory management haven't been considered to be an issue, since the company over a longer time showed very good results.

In Appendix B the purchased quantities in 2015 can be seen for item 1-4. Orders purchased today vary in quantities from time to time. Sometimes large quantities are purchased in one order, and sometimes very small quantities including only a few items have been purchased. By placing orders that include small quantities, the ordering cost will be higher per item but the handling cost will be lower. When placing orders that include too large quantities, the

risk of a high inventory handling cost will increase but the ordering placement cost will decrease. Today Amring does not include cost evaluations of the most optimal quantity that lead to the minimised total cost for an order placement. When an order has arrived to the warehouse in Arendal, the handling costs for reloading the truck is varying depending on the number of tires and the different variants in each container. The storage cost will increase the longer the tires need to be placed in Arendal. If Amring is delivering the wrong products to customers, there will be additional costs for replenishing the right item.

Since orders from Asia need to be placed far in advance, the risk of estimating wrong quantities compared to real time and not be able to cancel or change them during the way lead to unnecessary costs for Amring. The large quantities purchased from Asia also result in larger batches that needs to be stored in the warehouse.

The major concern expressed by many employees is that they today have too much products tied up in their warehouse, creating a situation that is very costly. Many of the products tied up in their inventory are products purchased based on gut feeling, and stay in the warehouse for many years. In general, the company do not use a proper strategy for how to deal with the products that has been placed in inventory for a long time.

Items stored for a long time need to be moved away from inventory. Amring prefer to reduce the price on those items, but sometimes they need to dispose and waste them. It's a trade-off here, since they are pushed by the owner company Pon to show good numbers, but at the same time they need to decrease the items in their warehouse. Therefore they cannot easily sell off the tires which have been stored for a long time, or at least not all at once, since it will show bad numbers in the budget. They have to sell off little by little instead which takes time and result in more old items than necessary in inventory.

4.3 Demand management

One of the reasons for the problems with forecasting the demand is that the demand is complex and hard to predict considering the distinct high and low seasons (Figure 12-13). The overcapacity and the availability on the market is also a big issue with the demand since if Amring has problem with delivering tires to the customer, the customer will immediately look for other suppliers. Weather conditions are impossible to forecast in the long run, and influence demand of tires since customers are more likely to change to winter tires when the temperature is decreasing which can happen in different periods from year to year. There are however some rules set by government saying that before 1st of December and 31st of March it is compulsory to use winter tires. From 1st of October to 15th of April it is however allowed to use winter tires. This means that end customers can change tires during a very long period of time. This uncertainty requires flexibility in capacity for incoming and outgoing orders at Amring. The demand is much lower during low seasons but they still need a small amount of tires if unforeseen events will happen.

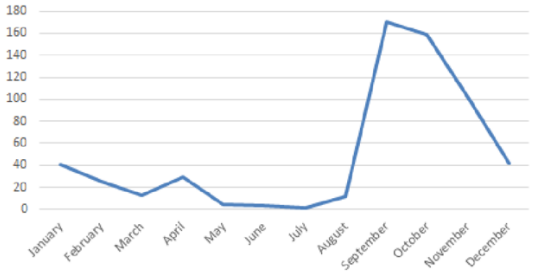

Figure 12. Demand variation for a fictive winter tire

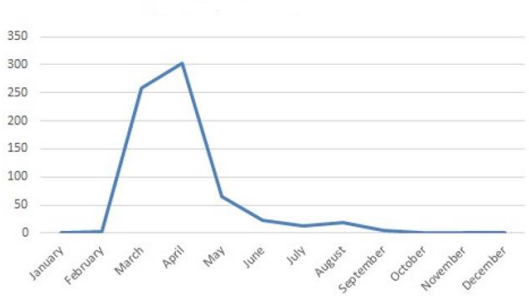

Figure 13. Demand variation for a fictive summer tire

The reason why Amring faces large uncertainties in their demand can also be derived to the fact that they have a broad customer base and the demand for a specific customer vary from time to time. Some customers are one-time-customers and some are recurrent from year to year. This makes it hard to plan for the future, since Amring wants to deliver to all possible customers that they can satisfy.

If the demand is low during the peaks where products are purchased, it will result in high tied up capital, and on the other hand if the winter comes early one year and the products are not yet in inventory they will risk to lose customers and instead have high inventory levels when the peak is fading out. This results in high inventory levels until next year of a specific product, if the forecast is bad. Tires cannot be stored forever since the rubber is getting old which sometimes lead to situations where the best before date has passed and the tire is impossible to sell off.

Order placement and lead times
Amring is offering a lead time within 24-48 hours to all of their customers. Most of the orders from Swedish suppliers are placed based on customer orders and a strategy where most of the purchases are based on their gut feeling of the current inventory levels. The strategy of using gut feeling means that the quantities are based on people's knowledge within the area of tires and where they are aiming in the future. The following parameters are usually included in the employees gut feeling:

- Increase/decrease in sales during the previous years of the tire
- Current plan of increase/decrease in sales during the next coming period
- Market conditions and what customers are expecting that influence sales
    - Campaigns
    - Discounts
- New released cars out on market that will affect sales of all tires

The lead time is usually one day from suppliers in Sweden. Suppliers with longer lead times within Europe send out the items usually when a container or a car is filled and due to the lead-

time of 7-14 days (sometimes even longer if the item are not in stock) there need to be a higher inventory level in Arendal, since the goods will not be replenished as fast as by suppliers in Sweden. For items shipped from Asia, preseason orders are placed and due to the lead time of 3-4 months, no rush orders can be placed afterwards. It is however possible to change the quantities +/- 15% before the goods are shipped from Asia. The number of items placed on each order is usually based on the parameters above.

The purchased and demanded quantities from 2015 have been summarized in tables and diagrams (Appendix B) and have been used to visualize the current levels for item 1-4. The inventory level for each month is based on the inventory level from the month before and the difference between the purchased and demanded quantities. The lead time is assumed to be 14 days from the supplier. The items that are not sold off during the year will be stored until the next coming year, and the risk of backlog when storing zero items are not considered in the diagrams or used further in this study.

4.4 Current forecasting and planning method

Amring is currently working in an ERP system called Visma and Excel when creating forecasts. The forecast is today based on the gut feeling of the employees and their knowledge about changes in the market when creating the preliminary plan for the season. Some items will be eliminated from the assortment to next season due to new variants. Changes in the market, if for example new cars are released, are also considered and included in the forecast. Sales people are out discussing with customers to get a feeling of how much the customers approximately need for the next preseason orders. These forecasted numbers are compared to the plan to optimise the final orders that should be placed for the next season. When interviewing the customers, they mentioned that Amring is usually collecting their data very late. The customers are not collecting any data about the end customer or use statistical tools that are shared with Amring. The meeting to discuss pre-season orders with customer is only based on their knowledge and no statistical point of sales data. Due to different lead times and contract agreements with suppliers, the orders have to be placed longer in advanced for some than for others. The forecast is created manually for all the items. The method used for the plan is created by the sales manager in collaboration with sales team and is performed as follows:

1. First, the total amount of sold products last year is summarized and separated into the different product groups, divided into summer and winter tires, and a number of expected products to be sold this year are calculated for each month (analysed on gut feeling and market conditions).

Brand/segment	Realisation	Jan	Feb	Mar	Apr	May
Conti.	-16 Budget	200	1800	3000	3500	288
Michelin	-16 Budget	230	1750	3100	3100	2900

Brand/segment	Realisation	Jun	jul	Aug	Sep	Okt
Conti.	-16 Budget	1250	900	850	700	500
Michelin	-16 Budget	2900	1200	950	750	550

Brand/segment	Realisation	Nov	Dec	Tot.
Conti.	-16 Budget	100	200	14180
Michelin	-16 Budget	125	200	15705

Figure 14. Example of forecast for sales per brand and month, based on fictive numbers

2. Each brand segment (Continental, Michelin etc.) is separated into an item level, to be able to calculate the expected sales for each of them (Figure 14). The sales of an item is based on the difference in percentage from the previous year and compared to the number of items sold. The percentage is multiplied by the estimated budget for 2016 to see how the number is changed. This will result in and estimated total quantity for the next year's sales.

3. When the number for 2016 for total sales during the year have been calculated, it will be divided into a monthly quantity (Figure 15). Depending on the estimated quantity of sales per month for each brand, a percentage for each month is calculated. This percentage, multiplied with the total quantity of 2016 for the item, will result in the sales per month of a specific item for the next coming year.

	Min.	Av.	Max.	Jan	Feb	Mar	Apr	May	Jun	jul	Aug	Sep	Okt	Nov	Dec
Conti.	32	267	877	39	282	643	943	432	244	150	99	90	32	10	0

Figure 15. Example of expected sales for a Continental tire in 2016, fictive numbers.

The fictive numbers used in the examples are collected from Amring's currently used numbers but modified to be able to show an example of how the situation can be. The minimum and maximum quantities are calculated for each item that indicates the quantity needed in each month to be stored in the warehouse. The minimum quantity is taken out from the month where there will be the least sales during the year. The maximum quantity is represented by the highest forecasted number for that year's sales. There are no monthly indications of recommended stock levels that are optimal to keep for different items during each month or time period of the year.

The forecast for the next coming year is also based on the vision and plan for increasing and decreasing in sales for different brands according to their future plan to expand or elimination of some brands and what they have delivered the previous years. For each product group, the forecast is based on the previous year. Since some items might have dropped in sales for the next coming year, or been sold to a lower margin they should not be forecasted to be sold in the same amount or to the same price as before. Another example is if items have been placed in the warehouse for a long time but last year many of these items were sold off to a negative margin, they are still included in the next years forecast, since they are not erased from the system. Today, these products with negative margin are erased manually from the forecast by the sales manager since they do not have any proper strategy or indications for eliminating them. This requires a deep understanding of the market by personal knowledge in the area, and the quantities are more or less linked to only one employee in the company. There have been risks before of purchases that only indicated that a large amount was sold the year before, not the reason behind the large quantities. The result of this is that even more items are hard to sell off.

4.5 Categorisation of items and service level

All items at Amring are given a specific categorisation depending on the sold volume, where A represents the largest volume and C the least sold volume. The categorisation is updated each quarter and a new ranking of the products is made based on their current volume of sold articles from the previous quarter of the year. This to make the categorisation representative with actual numbers of sales data. The split between the items are shown in Table 4. In addition to C items, which are the smallest volume items, the 5% are also represented by D, E and H items. D items means "dead stock" which indicates that D items have been in stock for a long time and need to be sold off. E items means "end of life" and this category indicates that the item is no longer

produced by the manufacturer. Items categories with H are the spiked tires, spiked tires arrives to Amring without spikes and when they have been spiked they are given a new article number. The unspiked tires need to be spiked before they are allowed to be sold. The categorisation is used when creating the forecast to make it easier to see which product are sold in small or large quantities, and therefore will be important for next coming sales period.

Table 4. Current split between categories

Category	% of sold volume
A	85 %
B	10 %
C,D,E, H	5 %

The categorisation is also used to define what service level is most appropriate for the different items. Since A represents the largest quantity sold, those items are today seen to require a higher service level. There is however no indication of exact service level, which is a reason why Amring today is not working with safety stocks. They only base the inventory levels on their gut feeling and the higher volume the higher safety stock. There is lack of control of what items result in backlog and thus should require a higher service level.

Table 5. Categorisation used in 2014 for item X and Y.

	Category	Quantity	Purchase price	Sales
Item X	A	2697	988 500	942 834
Item Y	C	12	11 750	18 745

Table 5 shows how sales of two products from different categories may look like for Amring. The numbers used are fictional but are obtained from real sales numbers in 2014 from Amring's database. The table shows how sales and purchasing may look like for products categorized as A and C with their current categorization method. The size difference in sales volumes for the two extremes are rather high, and clearly shows why the X product is categorized as an A and why Y is categorized as a C-product. The table also shows that the difference between total sales and total purchased looks very different for the products. After a deep evaluation of Amring's sales data, it has been clear that it looks like this for many of the company's products. Many products that are categorized as A has very large sales numbers, but the difference between sales and purchasing figures can be quite small, as it is in this example, where it actually creates a negative margin. The Y-product in this example is also representative, since many of their current C-products has sales figures which is much higher than purchasing figures and creates good margins, which is not always the case for A products.

4.6 Internal collaboration and meetings

There is a lack of internal collaboration at Amring. A lot of data from different departments are available but it is not used and shared by all employees among different departments, which result in misunderstandings and items are not sold. The sales manager use to have meetings with the sales teams, trying to indicate what should be sold during the next period. Purchase managers are not involved in those meetings, which result in a situation where purchased items

not match the vision and targets the sales people have since they are not given the same information and plan on the same basis.

There are no daily regular meetings performed at Amring, which makes it hard for the employees to connect to each other's departments but also be able to share daily information about rush orders or confirmations. A reason for this might be that there is no one responsible for this area, and especially no one responsible for the entire warehouse and the items to be sold, which makes it hard to blame a person for not doing his job. If someone felt this is my area of responsibility, it could result in a more pushing situation that connect the different departments and reduce the scrap in the warehouse. In addition, there are no weekly letters or weekly updates about the current situation and information about how items should or should not be purchased or sold.

4.7 Customer base and benchmark with competitors

The customer base of Amring is currently very broad. The various customers have different needs depending on which sort of end-customers they have. Some target to have so-called budget tires while other customers' request to have premium tires. Amring cannot make a generalization of what tires the customers want, since it differs a lot between different customers. The facts behind this are for instance where in the country the end-customer is located, the age of the customer, the customer's economy etc. It is also a great difference in size between the various customers. This is due to the fact that Amring has chosen a strategy to sell rims and tires both to end-customers and dealers.

According to the data about the size of the customers it was seen in the year of 2014, Amring had approximately 8035 customers which they delivered tires to. After an examination of the year 2014 sales numbers, it appeared that the major part of the sales quantities could be traced to a very small number of the customers. Also a very large number of customers purchased in total very small quantities during the year. All of the top 20 customers were so-called dealers. It should be mentioned that the number of sales do not include any financial results, only items sold. From 2014 year's data the following was obtained:

- Amring delivered tires and rims to in total 8035 different customers
- Roughly 715 000 tires were sold in total
- 20% of the largest customers generated 95% of total sales quantities
- 50% of the smallest customers generated 1,7% of sales quantities
- 1500 customers bought less than 3 items in total during the year

Amring can to some extent influence customer's demand though campaigns and discounts, but this is something they try to avoid since it results in lower margins. Some customers do have their own campaigns towards the end-customers while others feel that their margins are also rather low and therefore chose to exclude campaigns to their customers. Customer A believes that Amring should try to move back to the way they worked before when they used more campaigns, and not only for tires in need to get rid of. Customer A works with campaigns, and believes that it could be beneficial if this was planned jointly with Amring, to increase the interest of the end-customer. The dealers have quite large potential to influence the end customers. This is due to the fact that many customers have a limited knowledge in the areas of tires and rims. The end-customers are demanding more premium tires during the winter and care less about the quality of the tire during the summer, thus prefer budget tires during that time of the year.

The company has today no clear strategy of how they will segment their customers and differentiate bonus systems or services. All customers are treated the same way with discounts when purchasing larger amount of products. Amring is offering a bonus to customers buying a specific amount of products during each year. They are also offering a bonus to the customer whom first reaches a specific limit of sold products, and a bonus depending on the quantity the customer is buying. It has also been brought up that some of the larger customers dislike the fact that they have the same service and the same types of offers as the smaller customers. The larger customers and the sales reps believes that there should be more differentiation among the customers based on volumes bought each year and how long time they have been customers of Amring. It was mentioned by customers that they would appreciate better and stricter contracts that differentiate them in a better way than today. There is now a risk that they will lose customers since they feel they are not treated properly, according to the sales represent.

It is today easy for the dealers to influence the customers. The majority of the customers believed that the broad range of products were not necessary and could be decreased. Many of them had a negative attitude towards budget tires and said that they could strengthen the focus on selling premium tires to their customers instead. Employees at Amring try to phase out some variants by increasing the price for some other items and at the same time decrease the price on others where they expect to increase in sales, this to automatically guide the customers to buy other products instead.

The three customers included in this study have different opinions about Amring's performance and operations. One customer mentioned that Amring during the last couple of years had problems with keeping delivery schedules and to deliver the right products. These are although areas that have been improved over the last period of time. The delivery time as it is today is something many customers believe is good, but some also suggests that it could decrease in numbers without affecting their operations. Customer A was interested in the idea to have different delivery times on high versus low season. This since it still was of great importance during low season to have deliveries each day, since more end-customers come in on emergency change of tires, due to for instance flat tire. During high season Customer A means that it is much easier to plan for switch of tires since most changes are done at the same time as the change is made to winter/summer tires. Therefore it could be possible for deliveries just 2-3 times each week. This has also to do with the fact that it takes time to unload the truck, and it will be more time effective to then have fewer deliveries with higher fill rate. Customer A states it is more important to have deliveries during a certain time, instead of having short lead times. It is rare that the information obtained by the customers is considered to be of the secret sort.

As of today, the information from Customer A is not in a large extent shared with Amring, due to a lack of shared IT-system. The customer only delivers pre-season forecasts to Amring to let them know what they are planning on selling throughout the season. Customer A means that many dealers want to tighten their inventory, and have the right products, and by having better relationships and plan jointly with Amring, it will be easier to know what will be needed in upcoming season. As of today, no special or differentiated service is offered to the larger customers. Customer A believes it would be a good and interesting idea to let Amring control their inventory levels to optimize inventory levels and

increase the availability of the most used tiers for their customers. Customer A also states that sharing sales data is not considered to be a problem, since it is not of the secret kind.

At various time, Customer C has experienced they are not getting products at times promised by Amring. This is mainly an issue when products are not in Amring's warehouse and needs to be ordered from their suppliers. For that reason, the lead-time to the customer will be longer, but according to customer C, this is not the main problem. The problem is that Amring cannot at some occasions deliver these products at the time agreed upon, which result in an upset end-customer, since he will not have the tire at the time he is promised by the customer.

In 2014 Amring performed a benchmark to examine their performance in different areas compared to their largest competitors. The results gave indications of what their customers found important. The customers included in the benchmark claimed that the least important parts for them were product range/assortment and speed of delivery, among others. The company currently has very short lead-times out to customer. The customers also have the ability to choose between many different products. Among the most important parts considered by the customers were correct deliveries, knowledgeable staff and durability.

Tire hotels at customers

A trend within tire business is an increased number of end customers demanding tire hotels. Tire hotel is a place where end customers can drop of their tires and store their summer tires during winter, and their winter tires during summer season. For this, the customers have to pay a seasonal fee of about 600-1000 SEK/season, which gives a total storage cost per year of about 1200-2000 SEK/year for the end customer. The service included is except the storage place also the service of change of tires. Some customers also offer the service of cleaning the tires before storing them until next season. In addition, some customers contact their end customers in advance before it is time to change tires, to remind them of booking a time so they can change tires for the next coming season. Most of the customers have filled their tire hotels and want more space to be able to get even more customers. This service with tire hotels is not promoted by the customer, it is usually the same end customers storing their tires from year to year.

Transport system to customer

Transports in the surroundings of Gothenburg are carried out by car or truck usually within one day from the time an order is placed. At some occasions there may be deliveries up to two times each day, one in the morning and one in the afternoon. In Figure 16 it is shown how deliveries to a specific customer in the Gothenburg region during a week can look like. The customer chosen is one of the largest customers in Gothenburg and also one of the largest for Amring in total. The example shows deliveries during a time of year when it is high season, thus more shipments than usual. The numbers in the third column shows how many parts are included in a particular order. Each part is considered to be a tire and each tire weights approximately 10 kilos.

Date of transport	Year	Number of packages	Shipper city
2013-01-18	2013	3	Göteborg
2013-01-18	2013	8	Göteborg
2013-01-21	2013	8	Göteborg
2013-01-23	2013	1	Göteborg
2013-01-23	2013	4	Göteborg
2013-01-24	2013	10	Göteborg
2013-01-25	2013	4	Hisings Backa
2013-01-25	2013	4	Göteborg
2013-01-29	2013	20	Göteborg
2013-01-30	2013	50	Göteborg
2013-01-30	2013	50	Göteborg
2013-01-30	2013	83	Göteborg

Figure 16. Two weeks transport to specific customer in Gothenburg region.

Depending on the weight of package sent on each shipment to customer, the price will differ. Amring is currently working with a cost-matrix with their suppliers. As Figure 17 shows, the cost will vary depending on whether the packages are sent together, or on two separate shipments. In Figure 17 the numbers are modified since the information from the matrix is classified. During 2013, 1429 packages were sent to this specific customer in 1268 different occasions, which indicates there are saving potentials. There is although an important trade-off here for the customers and Amring, since good service is of great importance for the company at the same time as they are facing poor financial results. Some customers believe the short lead times result in great service while other large customers believe it could be interesting to investigate the suggestion of fewer transports each week. This since the amount of goods can be increased on each shipment, which they appreciate, since they do not have to unload, as many shipments as before and thus it will be more time efficient with such approach. It is costly for Amring to offer deliveries each day, since they need to pay for more transports. On the other hand, sales reps believe it is too risky to decrease the number of transports from how it is carried out today since they believe this will affect the customers in a negative way.

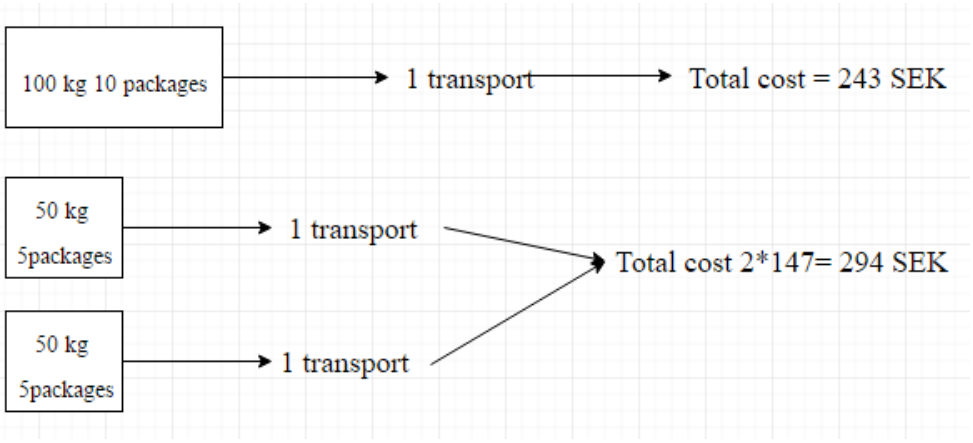

Figure 17. Example of transport costs for different shipments, based on fictive numbers.

4.8 Summary of strengths and weaknesses

The main strength in Amring's current performance is the high service level they offer to customers with frequent deliveries. The fact that they offer such a short lead time to customers and their large assortment of items customers possibly can buy straight from

their warehouse is an additional advantage in their performance. The fact that they have suppliers spread across the world is beneficial, since all business is not relied upon one supplier. It is the same with their wide assortment, the risk of only relying on one brand is reduced which decrease the risk of lost in sales.

Some areas were brought up as weaknesses in their performance. First off, their current strategy of purchasing items and how items are sold to customers are imbalanced, since as it is today the purchased quantities are larger or smaller compared to the demand by customers which lead to a mismatch and high tied up capital or sometimes risk of backlog due to inability to deliver. The information accuracy used as input to the forecast could be improved by getting better access to point of sales data from customers. The lack of data sharing and collaboration both internally but also externally have improvement potentials since as of today, no regular meetings are held with all employees at the company. The outcome from the current performance in certain areas are summarized in Table 6.

Table 6. Amring's strengths and weaknesses in current performance

Strenghts	**Weaknesses**
Knowledgeable order staff	High tied up capital
Product range/assortment	Lack of methods for forecasting and inventory management
Short lead-time	Information accuracy as input to forecast and inventory management
High service level	Lack of data sharing and collaboration
Spread of suppliers	Imbalance between purchases and sales

5. Analysis

This chapter includes an analysis of the empirical findings based on the theoretical framework. It starts by identification of the problem areas and continues with the inventory management strategies followed by the multi criteria approach and ends up with a chapter of how to improve demand planning and customer segmentation.

5.1 Identified weaknesses in Amring's supply chain

The main aim during the analysis has been to investigate and evaluate strategies and solutions resulting in reduction of unnecessary high costs that today cause problems in Amring's supply chain. This has been done based on the theoretical framework and empirical findings to improve Amring's current supply chain performance.

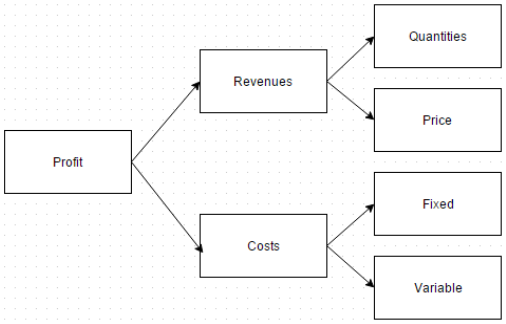

Figure 18. Cost breakdown of current situation

According to empirical findings, the negative spiral of losses has put Amring in a situation with lower profit margins the last years compared to previous years. The main reason for this can according to Figure 18 either be the revenues have decreased or costs are increased. The findings from the company of the strengths and weaknesses are summarized in Table 6. According to the empirical findings and their current weaknesses, the most urgent areas have been analysed and the focuses in this study have been derived to the areas presented in Figure 19.

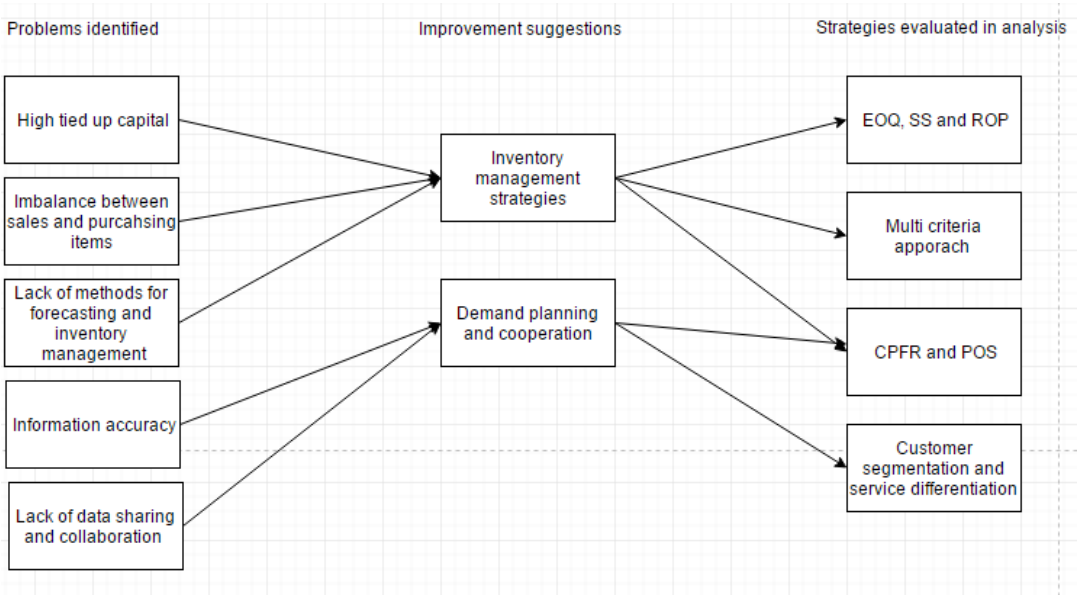

Figure 19. Detected areas of improvements and suggestions covered in the study.

The solutions and suggestions in Figure 19 of how to improve Amring's current situation are further explained in the next coming sections, with focus on how to manage the inventory and the demand in a way that will improve margins, decrease costs and eliminate the problems Amring is facing.

5.2 Inventory management strategies

The performance of inventory management have to be prioritised in order for an organisation to be successful, and to find the balance between the purchased and sold items. Amring has until now only based their decisions on a gut feeling strategy and therefore not analysed how the most optimal way of placing an order is for their current situation according to *4.3 Demand management*. This means costs included in each order are not considered, which has led to situations where quantities have been purchased departing from the optimal, which is costly and has led to high tied up capital and risks of stock outs. The order quantity is dependent on the handling cost and the ordering cost. The more items placed on each order the larger handling cost but the less ordering cost is included. Also, the other way around means the smaller quantities placed on each order, the larger ordering cost but the less handling cost as is illustrated in Figure 4. Planning for order quantities are crucial for organisations to keep inventory levels as low as possible. Due to this, it is crucial to find the most optimal way of managing Amring's order placements to be able to improve the current strategy used for managing the inventory levels.

According to Jonsson and Mattsson (2011), a matrix can be used to evaluate how a company should decide upon the right method for estimating the demand and to find a method to calculate the order quantity and the batch size (Figure 3). Analysing Amring's situation out from this matrix, they can be assumed to have large variations in the time of requirement when new items need to be purchased since the only thing indicating that new items should be ordered today is customer orders or if items are missed out in inventory, which vary a lot from time to time. This will place them to the right on the x-axis. Since Amring is facing seasonal variations in demand, they can be seen to have an unpredictable demand according to *4.3 Demand management*, but for some of their items it can be seen that the demand during low season and demand during high season can be assumed to be relatively stable from year to year, which makes it possible to more or less place orders with relatively same quantity from time to time, during different periods of the year. This will place Amring's order quantity, divided into different periods of the year, as relatively fixed on the y-axis and place the situation for those items higher up on the y-axis. Since the demand is not completely fixed, there still exists some variations, the suggested method needs to be modified afterwards and include practical parameters as well, to be able to match the purchases of Amring's demand more precisely. Only relying on theoretical values can according to Mattsson (2003) give misguiding numbers and therefore need to be contributed by practical factors as well. Hence, the analysed items used in this evaluation of Amring will be placed in the right hand upper corner in Figure 20, where the method of calculating the most economical order quantity with EOQ is suggested to be used, including calculations of re order point and safety stock. Mubiry (2015) means the EOQ formula can help to improve the planning and make order quantities more correct. This will lead to a situation where the purchased items will be more balanced and reduce the high peaks during the season to smooth out the demand and reduce inventory levels and high costs.

For items with large peaks during the year, where there are no indications that the demand can be assumed to be stable even during a certain period, there might be another situation and another method used for these items in accordance to the matrix. For this study, these items

have been left out and the focus has only been on one representative item with relatively stable demand during the periods.

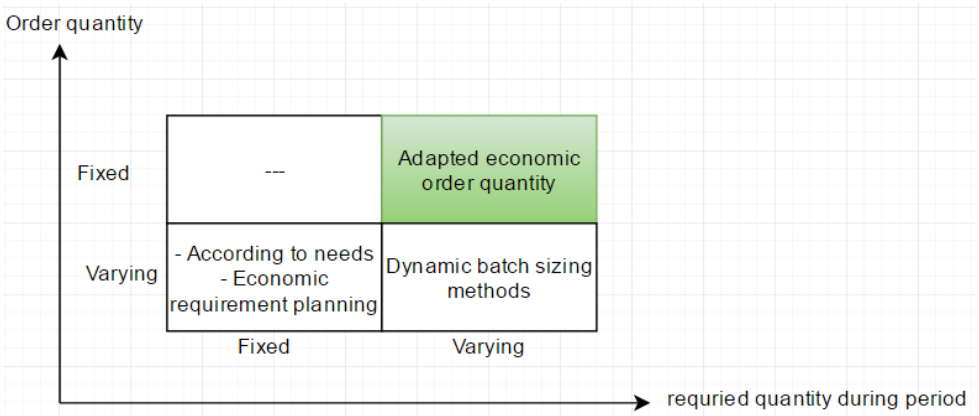

Figure 20. Analysis of Amring's situation based on order quantity provided by Mattsson (2003)

Before calculating the EOQ, the ordering cost and inventory handling cost have been estimated since they are included in EOQ formula. All values have been discussed with the logistics and financial manager at Amring to make sure they are representative. Mattsson (2003) stated costs that are included in the handling and ordering costs, as was summarised in Table 1, which was the base when collecting the costs from Amring. The result from calculations of ordering costs and handling costs can be seen in Appendix D.

5.2.1 Analysis of handling costs and ordering costs used in EOQ formula

The EOQ formula is represented by two costs; the ordering cost and handling cost (Mattsson 2011). What can be seen from calculations in Appendix D for the handling cost is when the quantity increase, the total cost for handling orders will increase. This is representative for all factors included in the handling costs due to the fact that they are incremental costs. For example, the time it takes to empty a container will increase the larger quantity handled, which result in higher costs. In addition, the cost of leasing trucks will increase the larger quantities are purchased since more trucks are needed. The larger quantities the more cost of employees that can handle the larger quantities are needed in the warehouse and in the organisation. The storage place as well as the total rent of the warehouse will increase with the order quantity. When Agility starts to operating in half of the warehouse, the cost will decrease but the smaller quantities can possibly be stored in the warehouse. This due to the fact that it is paid per square meter used today, and if the quantity is increasing the larger space is needed which result in additional costs of warehouse. All of the costs included in the handling costs are represented by costs that increase with an increased quantity, which indicates that the handling cost used in the analysis of EOQ are all incremental and not fixed costs.

When analysing the ordering cost included in the EOQ formula, it can be seen that it is decreasing with the larger quantity placed on each order. In opposite to the handling cost, the ordering cost will decrease with the larger order quantity. Costs included in ordering cost are decreasing per item the larger amount that is placed in each order, so the invoice payment that it takes for one employee to manage, will be decreased the larger quantities that are placed on each order. Also the larger quantities that are placed with each order, the fewer orders need to be placed which reduce the order placement costs that the purchaser is managing. The external transportation cost will decrease the larger the orders are, since fewer shipments are needed.

Since the costs for Amring of for managing orders are decreasing and increasing as the order quantity is increasing, the aim with the EOQ formula is to find the optimal order quantity that result in the lowest cost per order. This by matching the handling cost with the ordering cost and find the lowest total cost to improve the problems Amring face today with too large or small quantities placed on each order that lead to unnecessary high costs in the end.

5.2.2 Calculation of economic order quantity

The economic order quantity formula presented in *2.3.1 Inventory management method with optimal order quantity* has been used to be able to find the most economical way of placing orders that will result in a reduced tied up capital. This formula was used due to the fact that the evaluation matrix in Figure 20 indicated that the method of using EOQ on those items were suitable.

When analysing the empirical data and when evaluating what segment of products is most useful for this way of placing orders, it was shown that this method might be suitable for items supplied from Europe since the lead time of 14 days indicates that this method can be used to calculate the optimal order quantity. Orders from suppliers in Asia are exclusively preseason orders, and suppliers in Sweden is offering such a short lead time meaning that this strategy is not the most optimal for those orders. However, the calculations of EOQ can be performed for all orders but not applied straight off due to constrains of short and long lead times but to get indications of what the optimal order quantity could be.

When deciding upon items to evaluate in this study to prove that the method could result in potential improvements, it has been of high importance that the items have an assumable stable demand during the peak but also during the rest of the year. The items used are representative for relatively commonly sold A-items. They were discussed with employees at Amring in order to prove that the items are representative for European suppliers. The items will further on be named as item 1-4. When applying the method, the following parameters have been in focus to see how the performance have been improved:

- Reduction of inventory levels during the year to reduce tied up capital
- Smooth out the purchased quantities during the periods
- Match between purchased and sold products
- Reduction of inventory costs

The aim has been to compare the current state of purchased items in 2015 with the new way of placing orders with EOQ, to see if there could be improvements with using a method suitable for Amring's demand on item 1-4. All calculations of EOQ for the items have been collected in Appendix E. During a certain period, it can be seen that it is suggested to purchase for example 3*EOQ, which indicate that 3 orders of EOQ need to be placed during the lead time. In some cases, it has been assumed that the EOQ from the period above is placed and have thus been calculated for the next coming period.

The EOQ formula includes the price of the item, holding cost factor, ordering cost and demand of a certain item during a period as can be seen in the formula presented in *2.3.1 Inventory management method with optimal order quantity*. The larger ordering cost and the larger demand, the larger value of EOQ will be obtained. The larger holding cost factor and the larger price of the item, the smaller will the EOQ value be. In this case it has to do with the fact that the most economical factor to order is when the ordering cost and holding costs are balanced.

5.2.3 Safety stock level to increase control and reduce the risk of backlog

In parallel with the implementation of EOQ, Jonsson and Mattsson (2011) suggest to calculate the safety stock level to be able to increase the control and manage the inventory levels more efficiently. During analysis of the current state, it was clear that there is no proper way of managing the orders and inventory levels and the gut feeling is working as a base for the next coming order placement. This has resulted in situations with stock outs and risk of losing customers, but also higher inventory levels than needed for some items. Both too high and too low stock levels will result in higher costs than necessary for Amring. In addition, when analysing the forecast method used today, there are only indications of min and max value of inventory levels suitable for the whole year, which is not representative for all periods during the year. For this reason, this area has been prioritised when looking at improvements to reduce costs.

Managing the inventory levels can be done by calculating the safety stock levels, and the idea is to find the optimal level during different periods of time that follows the demand to adapt to the current situation and result in the lowest cost. Demand for item 1-4 is varying during the year after high and low season variations, and the inventory level need to follow this in order to not have too high stock levels. Therefore the safety stock levels have been calculated for different periods of the year, the same periods used for the EOQ.

Since no service level has previously been used at Amring, the service level has been assumed to be 98% for all items used in this analysis, since all items are represented by category A according to their current categorisation of items which indicates that they should have a high service level. The reason for assuming that 98% is a suitable level is due to the fact all items had almost the same frequency of orders, and thus were assumed to require this service level and is also a reason for using the Serv 1 formula presented in *2.3.3 Safety stock and re order point*. A service level of 98% is represented by k-factor 2,05 which has been used when calculating safety stock level for item 1-4. The formula used for calculating safety stock (SS) is presented in *2.3.3 Safety stock and re order point*, which represent the standard deviation multiplied with the safety factor. The larger variations in demand, the larger will the standard deviation be, which results in a higher level of safety stock. On the other hand, if the demand is relatively stable during a period, the safety stock level can be reduced since the standard deviation will be smaller for that period. The safety factor, which depends on the service level, also indicates how large safety stock should be with regard to how valuable the item is, which means how sensitive the item is for stock outs. All calculations for SS can be seen in Appendix E for item 1-4.

By getting indications of the most suitable safety stock level that vary during different periods of the year in the same pace as the demand is varying, a better control of when orders need to be placed is obtained. This implementation will avoid issues with backlog but also reduce the risk of high tied up capital since it result in a better control and thus an improved supply chain performance.

5.2.4 Analysis of re-order point

Calculations presented in Appendix E shows that with help from a calculated re-order point (ROP) in addition to the calculated SS and EOQ can help to reduce inventory levels. The idea with calculating ROP level is to find the limit that gives indications of when a new order should be placed to cover for the lead time and make sure new items are replenished the time they are needed. It indicates when a new order needs to be purchased, and with help from EOQ, the

optimal level that should be included in the order is calculated. Formula used when calculating ROP can be seen in *2.3.3 Safety stock and re order point*.

The levels calculated for ROP is dependent on the levels of safety stock, since it is the safety stock plus the demand during lead-time that results in the ROP level. The more the demand is varying, the larger will the standard deviation be, which result in a larger ROP value. The idea here is to have higher safety stock and ROP to cover for the uncertainties and to be able to deliver even if a customer order is large or small. Since the ROP in addition to SS also include the demand during lead time, the total value of ROP will be the highest if the demand during lead time is large and there are large variations in demand and the item requires a high service level. The longer lead time the higher ROP. Therefore some calculations of ROP are larger than for others, as can be seen in Appendix E for item 1-4, and therefore need larger space in inventory during different times of the year.

5.2.5 Result of implementing EOQ, SS and ROP strategies

The result from the calculations show that there will be both a reduction in inventory levels during the period and a more smooth way of placing orders that better match the demand variations. It also reduces the total amount of purchased quantities during the year in total. Since a method is used, there will be less risk of the human factor and the risk of estimating the wrong quantities, since when comparing with a method for the optimal quantity, it gives indications that an order should be larger or smaller than the gut feeling value. It has also been proved that the inventory cost will decrease, and since the turnover rate is dependently on how many times per year new items are replenished (formula for turnover rate can be found in *2.3 Inventory management*) it will also be improved.

When calculating the inventory costs, numbers from Appendix C were used. The result of implementing this inventory management principle with using EOQ, ROP and SS can be seen in Appendix E.

Item 1

The result from the analysis of item 1 is that the purchased quantities will be smoothed out during the year if purchasing quantities according to EOQ formula, which according to Appendix E and Figure 28-31 will reduce the cost and tied up capital. The year was divided into 3 periods to get a stable demand that was representative. Cost calculation indicates that there is a potential cost savings of 77% if using the EOQ method instead of purchasing according to the approach used in 2015. The total savings for this item will with the implementation be 5269 SEK. The result also indicates that in total 654 items were purchased compared to 2015 when 800 items were purchased. The quantities were in 2015 purchased during 2 times, which indicates that the turnover rate was high, but with this strategy, orders are placed more often which lead to a situation where the turnover rate will increase.

Item 2

For item 2, there were indications showing that the year could be divided into 4 different periods to get a relatively stable demand to base the calculations on (Appendix E). When analysing the result of the calculations with EOQ and comparing the inventory levels, purchased quantities and the costs for holding inventory, all areas are improved and reduced for item 2 after implementation of EOQ, SS and ROP. The costs and items in inventory will decrease with 25% compared to inventory in 2015 (see Figure 32-35, Appendix E). It also indicates that the purchased quantities per order are reduced in total during the year, but also on a monthly basis (see Table 7 and Appendix E)

Item 3
It has been assumed that item 3 has 3 periods with relatively stable demand during the year. As can be seen in Appendix E and Figure 36-39 the SS, ROP and EOQ have 3 different values depending on which period that is represented. First, the demand from January to April is zero, demand from December/May to August/September has been assumed to be representative as stable, and the demand from October to November represents the last period.

The result of the calculations with EOQ indicates that the inventory levels during 2015 can be reduced with 91% by using EOQ formula to calculate the optimal quantity instead of using the gut feeling. In this example it is a clear indication that if one order is misplaced, many items will stay a very long time in inventory and thus result in high costs. By carefully evaluate and place orders that are optimal in size and cost, the level can be largely reduced. The inventory level is directly connected to the high costs in inventory. For item 3 in 2015, the costs could also be reduced with 91% (Table 7).

Item 4
As can be seen in Appendix E, the total inventory level and the total purchased quantities during the year will be higher compared to the levels in 2015. Also, the demand is unstable and even if there are some indications that make it possible to divide the year into different periods to reach a relatively stable demand, the demand vary quite a lot. However, as can be seen in Figure 40 and Figure 42, the purchased quantities will be lower per occasion when an order is placed compared to the way of placing orders in 2015. Even if the total amount is larger during the year, the levels in inventory will decrease since the purchased quantities are more related to the real demand variations. The result also indicates that due to the service level and relatively large variations during the periods, the levels are higher compared to the other items used. This result in higher stock levels, to cover for the uncertainties. Even if the levels are calculated to be higher with the method EOQ method, there might have been a risk of backlog in 2015 due to too low inventory levels, and this risk is more costly for Amring compared to having a higher number in stock. Also, the levels are not adapted to the current demand, which is another reason for starting to work with a method that covers up for this. The costs for inventory will compared to the year of 2015 increase with 4%, which in total is a very small number compared to what is possible to save from the reductions of item 1.

Table 7. Potential improvements after implementing EOQ, SS and ROP item 1-4.

	Purchased quantities in total	Inventory cost in total (SEK)	Min value (items)	Max value (items)	Potential change in inventory costs
Item 1 before	800	6843	300	500	
Item 1 after	654	1574	51	278	– 77 %
Item 2 before	5354	4709	60	2020	
Item 2 after	5403	3540	46	2040	– 25 %

Item 3 before	1730	6901	36	429	
Item 3 after	671	623	33	230	– 91 %
Item 4 before	665	697	1	542	
Item 4 after	698	700	23	341	+4%

Table 7 shows the result, which indicates there are large potentials for improvements. For item 1-3 there will in total be large inventory savings, both in space in inventory during the year but also in costs. As can be seen for item 2, the difference between min/max values will be larger after the implementation but in turn it results in a largely reduced inventory level. In the case of item 4, that increase with inventory level of 4 % in total during the year, the way of how to purchase the items to eliminate the risk of too high stock levels will be reduced, since it was in 2015 purchased during one month 542 as the most, compared to the new method where the largest amount per month is 341 items instead. In addition, item 4 had zero items during a long period in 2015 which indicates there is a large risk of backlog, so an increase of 4% is highly motivated for this item. This indicates that even if there are no large changes, the way of purchasing is better with the EOQ method.

The total savings of purchased items for the four items used in this study is compared to the year in 2015 where it together was 8549 items compared to if using EOQ model the result is 7426. This contributes to a reduction of 13%. The total demand of all items in 2015 were 7180, which shows that the method not only smooth out the demand by purchasing more optimal quantities from time to time, but also match the demand better than the currently used approach for purchasing orders.

As can be seen in the summary in Table 7, some inventory- and purchasing levels will be increased and some largely decreased. For all of the items, the service level will increase due to the fact that SS and ROP are implemented, which reduce the risk of backlog and enable Amring to offer better service to customers. In total, the method has proved that there will be savings, improvements and cost reductions compared to the way item 1-4 were purchased in 2015.

5.2.6 Sensitivity analysis of costs impact on order quantity

To be able to see how the handling cost (I) and ordering cost (S) is affecting the result while they increase or decrease, a sensitivity analysis has been conducted to increase the robustness of the result, based on the calculated EOQ values. The analysis has been done for item 1 in order to see if the EOQ still will generate almost the same number even if the costs included in the formula are changed and depart form the optimal value.

The sensitivity analysis started off by defining the upper and lower limits compared to the values calculated and given by the logistics- and financial manager (Appendix D) that has been used when conducting the EOQ, SS and ROP strategy for item 1-4. In comparison to this, the variations used as min/max for the handling- and ordering costs can be seen in Table 8. The

numbers used as upper and lower limits were seen to be reasonable assumptions to be able to conduct the analysis.

Table 8. Under and upper limit used for sensitivity analysis

	Under limit	Calculated value	Upper limit
Inventory holding cost factor (I)	0,15	0,195	0,24
Ordering cost (S)	1000	1576	2000

Two analysis approaches were evaluated to see how they differ from the used value and how it influence the total ordering quantity. The following combinations were used:

1. Analysis of how variations in inventory handling cost factor influence the optimal order quantity
2. Analysis of how variations in ordering cost influence the optimal order quantity

The result from Figure 21 show that the impact of variations in the holding cost factor will not influence the order quantity drastically. This means that it is not sensitive to changes, which Mattsson (2003) also states, that the total cost curve is relatively flat, which means that small changes will not influence the quantity remarkable. The same result is for Figure 22, where it can be seen that small deviations from the optimal order quantity will not influence the ordering cost especially much. However, as can be seen, the impact will be greater the larger order quantity that has been used in the calculations.

The result from this analysis proves that it is important to adapt the optimal order quantity to other practical factors that have larger impact on the total cost curve, which needs to be evaluated before placing an order.

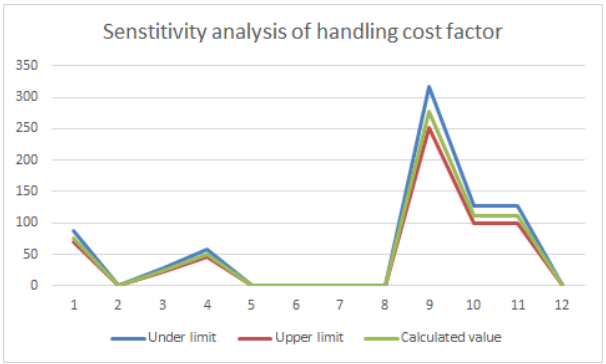

Figure 21. Analysis of how holding cost factor impact the order quantity

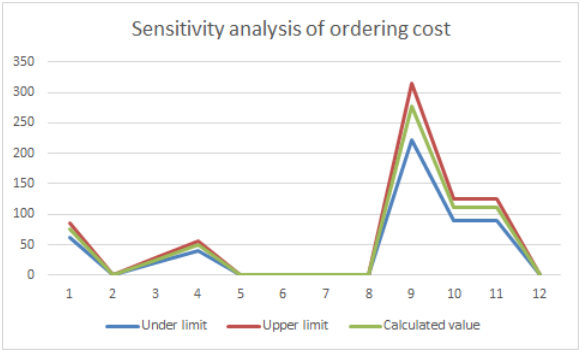

Figure 22. Analysis of how ordering cost impact the order quantity

The result from Figure 21 show that the largest difference in quantity during the investigated period is 17% from the lower to the upper limit. This is only a difference in purchased quantities with about 27 items if the upper limit and lower limit were used, so the holding cost factor will thus not affect the quantity remarkably. The same result is obtained for Figure 22 where the change in handling cost from upper to lower limit only will result in a changed order quantity of 25% for the largest peak (and thus will be even smaller for the rest of the period), which represents a result of 49 items. This difference will therefore be seen as a robust result, even if the ordering cost will be changed remarkably.

When evaluating how EOQ and inventory levels will be influenced by the changes in ordering- and handling costs, it can be seen that the economic order quantity will depart 8% from the calculated value if the under limits are evaluated and 16% when upper limits are obtained based on numbers from Table 8. This will in turn result in an increased inventory level of 12% for item 1 for the upper limits, and a reduction of inventory levels of 27% for item 1 if the under limits are evaluated. Since the upper- and under limits are rare to happen, this change will probably not influence their operations since the values will not depart this much from the calculated values.

As a way to start improving the usage of a method for optimal order quantities, it is important that all departments can take part of the calculated and given information. Without a forecasting method it is much more challenging to involve the departments on the same basis, since there is no clear motivation to the different numbers given. By using a method instead, the data can easily be motivated and shared among departments. Even if some calculated numbers might be changed due to some restrictions, it still works as a direction for knowing how to purchase out from a given EOQ, safety stock levels and re-order points.

5.2.7 Service level

When implementing the use of safety stock levels, it is important to consider and segment different items in accordance to its value. This according to Naylor (1996), who means that segmentation of items makes it easier to know which items are in need of a higher safety stock and are more sensitive to stock outs. The safety stock level will increase the more important the item is, as well as how sensitive the item is for stock outs. In the above example where calculations have been done for items 1-4, they have been assumed to be in need of a high service level due to the fact that they are today ranked as A. Amring is currently not working with any service level structure according to *4.5 Categorisation of items and service level* despite the fact that they are using a categorisation of their items based on ABC, which could work as a base for levelling the service. By ranking the items, Boylan (2008) means that a better service can be obtained to the items of high value for the company. Offering the same service for all items can be costly since it results in a higher service level than customers are requiring.

An example of a way to structure the service level is to rank the items out from one or more parameters such as volume, price or order frequency and thereafter match the different categories to a suitable service level. This will not only reduce the costs for Amring, it will also improve the control both within the warehouse but also when making forecasts, since the one with highest service level is more critical and needs to be updated more often. It is also an indication of which safety stock level is needed for the different categories out from how high or low service level that is needed for Amring. The higher service level that is proposed for the item, the higher will the safety factor be and in turn the safety stock level.

5.2.8 Multi criteria approach to segment items based on volume and margin

There are indications showing that the current forecasting method of Amring can be improved according to *4.4 Current forecasting and planning method*. The current classification can be considered to be misguiding, since the method used is based on gut feeling and indications from volume, and therefore it is believed that it can be misguiding to use this sort of ABC-classification as indication for creating the forecast and managing the inventory.

The traditional way of using the ABC analysis has been around for many years, and has been used in many different business areas to examine which products that have the largest effect on the business, thus which should be focused on. Over the years, the classification method has only been based upon one criterion, just as it was meant to be from the very beginning (Flores and Whybark, 1987). This is also the way that Amring has applied the method in previous years. In the literature, many base the Pareto-analysis on the items dollar-usage, but in this case, the ABC-classification has been made on the basis of volume for Amring's products. If companies only use one criterion, there could be an imminent risk that the classification can be misguiding, compared to if other inputs were included as well.

What will be proposed to Amring's categorization is to introduce more factors to increase the accuracy of the categorisation. Flores and Whybark (1987) proposes a multi criterion categorization. For many products, as is the case for Amring as well, additional criterion may be representing important consideration for the management when planning for inventory management and for the forecast. Some criterion may even weight more heavily than the one chosen from the beginning. The current classification method does not give any indications of how the specific margin looks like, if it is negative or positive. Such indications can prove that the product is not generating positive results for the company, even if it is sold in a large quantity over the year. If the current classification method is used, a product with high sales numbers can be classified as an A-product, but does not give any indication about the margin. This creates an obvious risk of focusing on products that should not be focused on. One risk could for instance be that a product with an A-classification will be purchased in large quantities, and will thus take up great amount of space in the warehouse. It will also lead to a situation where more focus will be put on this product compared to a B or C item, which perhaps would not be the case if other factors were used as input for the categorization. The method of using one criterion classification can create less robustness and unstable guidelines of which products to target. In Amring's case it is of high priority to improve this area since they are facing too high inventory levels and too many different sorts of items. In order to improve the forecast and inventory management, a new way of working with product categorization is proposed.

According to Flores and Whybark (1987), using a multiple criterion ABC classification, companies can improve the inventory reduction and better meet delivery schedules. Both inventory reduction and meeting delivery schedules are areas that have been highlighted in *4.5*

Categorisation of items and service level as problem areas for Amring during the years. The approach used in the study by Flores and Whybark (1997) proposes to start off by doing a so-called ordinary ABC classification, using only one criterion, in this case the sales volumes. This will be made by examining a large amount of historical data. Next step is for the management group to review the classification. This approach will in this method be a bit modified to better meet the issues of Amring, and therefore the management review will be done after the second ABC-categorisation is created. To strengthen the classification, the margin of the products will also stand as a ground for the classification, where the margin equals the result for each product. When the margin is compared to the sales volume, and preferably also compared to the order frequency, it will create a more robust result to determine the categorization on. It will more precisely present which products that both are sold in large volumes and generates positive revenues.

After the categorization out of net margins and volumes are made, the management will perform a review of the categorisation. The management review includes the criterion "criticality" (Flores and Whybark, 1987). The criticality criterion contains of areas that the management believes are critical for the product, and may vary from company to company. The input to the classification is often cost-based, for instance margins and volumes, which have been used for this categorisation. This information is for some products insufficient, and additional information may be of interest. As can be seen in *4.3 Demand management*, Amring's suppliers are spread over a large area, which influences the lead-times quite a lot. Therefore the lead-time could for instance be one parameter, which the management should take into consideration when reviewing the classification of the products. It is also important for the management to decide upon which categories, volumes and net margin that is considered the most important for the classification (Flores and Whybark, 1987). In this study, the management principles have been left for future research of the study, and thus will not be considered in the calculations of the new categorisation.

By using net margin and volumes as inputs to the classification, nine new categories are created, as can be seen in Appendix G. Flores and Whybark (1987) states that it is of importance to keep these categories down since each combination may need different management policies, otherwise it will be too complex and hard to manage all different policies and rules on how to treat different categories. How companies create the management principles differs a lot, and in some cases they can be quite fuzzy and not organised at all. In Amring's case, it is considered advantageous to have clear guidelines on how to handle the different categories. The reason for why management principles should be used for their categories is that they need to get stricter guidelines on how to deal with their different products on order to increase their turnover rate and reduce the number of products in stock. These two areas are those that have been highlighted as problem areas in Table 6, and therefore guidelines should be set for products to target the problem areas.

By introducing the multi criterion categorisation to categorise products for Amring, the company will be able to have a more stable and robust fundamental information to classify its products. Since the forecast and inventory management is partly based on the classification, this new approach could lead to a more accurate forecast and a more accurate way of dealing with the products to optimize the inventory. The only indication used in the current method for the forecast is the previous year's sales and the knowledge of the employees, which is insufficient as a ground for the forecast. Both of these variables will, as proposed, still be used, but with additional information. The new approach enables to see which items that generate the

largest margin per item but also for the whole product group, and not only the largest sold volume for the previous years.

In previous approach, when only the volume and knowledge was used as the basis for the categorization, there could be an imminent risk that products were forecasted in the wrong way. It was with that approach difficult to deduce the products to which the profit they actually contributed with. For instance could a product last year be sold in very large quantitates, but this could be traced to the fact that it was going to be deleted from the current product range, and be replaced by another product in upcoming period. Due to this, the product was sold out at a lower price in the previous year, and therefore Amring would not earn anything from the sales. With the new approach it will be easier to see if they actually sold much and what they earn from the sales.

As was seen in *4.5 Categorisation of items and service level* and Table 5 there are indications that even if the item generates a negative margin, it remain in category A due to the large volume sold. With the new categorisation, it both indicates the large volume, but in addition also the margin will now be known (Table 9). The margin has been calculated in accordance to the difference from sales price compared to the purchase price. The margin per item was calculated by dividing the total margin with number of items sold during the year.

Table 9. Example of new categorisation with regard to margin value

	Category volume	Quantity	Total purchase price	Total sales	Total margin	Margin per item	Category margin	Multi category
Item X	A	2697	988 500	942 834	–45 666	– 17	D	AD
Item Y	C	12	11 750	18 745	6 995	582	A	CA

Pareto's law, presented by Suresh (2013) has been applied when giving the new categories of value per item, in order to get the A items as items that generates 80% of the total margin, B items as the next coming 15% of the margin, and the last 5% represents C. The new categorisation has been divided according to Table 10. In total there are 7693 different items handled in 2015.

Table 10. Split between categories with new categorisation value/item

Category	Value/item	Number of items	Number in %	Generate total margin
A	>150	2693	35 %	80 %
B	150-115	1000	13 %	15 %
C	115-0	3154	41 %	5 %
D	<0	846	11 %	negative margin

When examining the new approach, it could be seen that many of Amring's products were developing a negative margin. It could also be seen that many of the products that were developing a negative margin were products that before had been classified as an A-product. Out from this categorisation, there were in total 11 % of the items that in 2014 generated a negative margin and obtained the classification D. There are two possible solutions proposed for a product classified as a D-product. Either, it will be moved from the product range, since it is not contributing to increasing the profit for Amring. The second option is to examine how the pricing of the product is set. Here it could be a great opportunity to increase the profit for the company by just alter the pricing of the product or negotiating with the supplier for better purchasing price. This of course requires that the product is sold in large volumes, and that it is not scheduled to be replaced by another product in the up-coming years. By using the new method, Amring can reduce the number of scrap-products in inventory, improve the forecast accuracy, improve inventory management and increase the profit.

The previous strategy of Amring has been to sell as much as possible in volume, since that gives good results in one way, but a consequence of this is that it is not considering which items that actually generates the most revenues there is a risk of low margins as can be seen from Table 9. The new category can be used when setting the price of items, to see that for example an item AD might be supported with a new strategy, at the same time as a CA item should try to be sold even more since they generate large margins. By implementing this into the Visma system used today, Amring can get better control of which items are more sensitive and thus should be purchased more carefully. At the same time sales people get indications of what items they should try to phase out to improve the profit and results. According to Chapter *"4.1 Product range",* Amring wants to increase sales of premium brands, and with help from this improved categorisation, it is an efficient way to see which items should be in focus when trying to increase sales. Since premium brands are today represented mostly by category C, if they by the new categorisation will be ranked as CA, it indicates that they are the most prioritised to increase sales on at the same time as CC or CD indicates that the item might be eliminated from the assortment.

Since different items with different categories are in need of different service levels, as was stated previously, it is also of high value for the company to look for the possibility to use another strategy for the items ranked as CA. Today many of the C items are supplied from local suppliers, with a short lead-time. By trying to find a way of supplying these items directly from supplier to customer without storing the items in Amring's warehouse it is possible to reduce inventory. CA items are usually held in small quantities, and therefore hard to forecast. By the new differentiation, it is possible to use a strategy that both benefits Amring, but also increase the service to customer. In addition it is of high importance to try to segment the customers to know where to implement this strategy and what other different services that might come with the new solution.

5.3 Improved planning of demand uncertainty and increased customer knowledge

After an evaluation of Amring's customers, it was clear that the customer base of the company was very broad. According to *4.7 Customers and benchmark with competitors*, it is a need for a new strategy for segmenting and differentiating customers and customer service. Amring needs to understand that different customers have different economic value for the company, and should thus be handled in different ways. It can be rather costly for Amring to have the same service for all their customers and to differentiate the service is good for more reasons than the financial reason.

In *4.7 Customers and benchmark with competitors* one can see that a very large amount of Amring's customers are considered to be very small and stands for an insignificant part of the total sales during the year. 95 % of the customers stand for 1.7 % of the total sales. On the other hand stands a relatively small part of Amring's customers for a significant part of the total sales during the same year. As it is today, Amring is treating all customers in a relatively similar way. There are indications of irritation from larger customers that they should get a better treatment or specialized service, compared to the smaller customers. Customers are offered similar price differentiation and bonus system, which has created a situation where there is a risk that larger customer can turn to other suppliers instead.

To improve the ability to retain large customers and increase their buying power potential, it is considered important that Amring tries to find a better customer segmentation and customer service differentiation, in parallel with the new multi criteria segmentation of their items. It is important to find the customers of Amring that actually create the highest value for the company. It is also important to further investigate how the customers different buying patterns looks like, depending mostly on area and age. Depending on those patterns, Amring must become better at targeting offers and improve the ability to guide the customer into buying tires that the company will earn the most from, while at the same time make the customer satisfied with its choice. This could take its form as steering customers to buy more expensive tires in areas where the economy is strong and direct customers to more expensive budget tires in areas with high proportion of senior citizens.

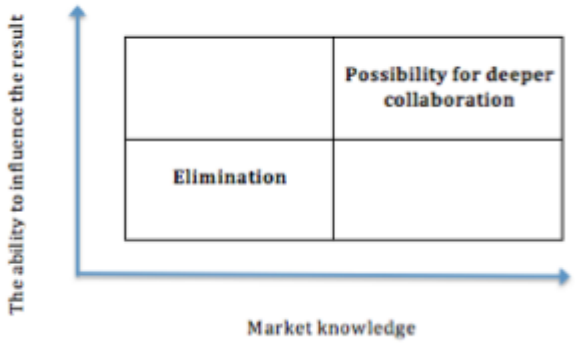

Figure 23. Differentiation matrix used for segmenting customers

Amring needs to be careful when introducing deeper relationships with specific chosen customers. The important part for Amring is to build stronger relationship with the customers that have the biggest possibility for growth for the company. However, segmenting customers based solely on their ability to create good results for Amring is not enough. Other criteria, in addition to possibility of growth, should also be included when deciding which customers Amring should put extra focus on. An additional criterion that is suggested for Amring is market knowledge. These two different aspects are used in this project due to the fact that it is important that the customers are chosen so that they can in a positive way affect the profit. Possible customer to do so are of course the larger once. But it is also important that the customer have good market knowledge. This since more planning will be performed jointly, it will thus be beneficial for both parts if the customer have a good market knowledge, since they will in another way then understand what Amring can actually deliver and what they are capable of. If both parts understand each other in such way, it is believed that the relationship could be optimized in another way than if the customer were not as knowledgeable about the market.

Out from market knowledge and the ability to affect Amring's profitability, a matrix has been created (Figure 23).

This matrix (Figure 23) is not including all factors used when evaluating the customer base, but act as a starting point for the segmentation. As a complement to the matrix, other factors should be considered when segmenting customers. As a complement to the matrix the following factors were also considered when deciding upon the most suitable customer to start deepen the relationship with:

- Customer behaviour (recurrent customer, purchasing from Amring steadily over the years)
- The connection to the focal company (long time customer to Amring)
- Quickly payment, no issues regarding payments over the years.
- Possibility to affect and influence
- Possibility to do the investments required for the relationship
- If it's a large customer with many dealers

Approximately 1500 customers bought less than 3 items in total during the year of 2014. Analysing this from a broader perspective and in the long-run, it can be seen that a lot of time is spent on these very small orders and it is believed that it would be better if these small customers instead turned directly to large dealers to change tires and rims. This could also affect the optimal order quantity that govern the purchase of stocks where there may be a risk that small purchases from small customers are spread to also be small purchases from the purchasing department to the warehouse. This will lead to an inaccurate way of purchasing goods to the inventory shelves since it will not follow the inventory management method with EOQ, addressed in previous chapters. The elimination of these customers is based on the matrix seen in Figure 23. This due to the fact that the market knowledge of these customers is very low and they stand for a negligible part of the result. The important customers for Amring are the ones with high market knowledge and which influence their profit the most. Since 20% of the customer's stands for 95 % of the total sales, these are the ones which should be focused on, and some/a few of these are the customers that could be included in a possible pilot project. For the initial part of this differentiation project it is considered to be best to choose a customer located in the immediate area of Amring in Arendal.

It is believed that they must in new ways get in touch with customers and through segmentation and a differentiated service this can be done. If Amring follows the matrix in Figure 23, their most important customers can be chosen for a new service differentiation. For the Amring to continue to increase their sales, they need to find a role as key supplier for their most important customers. By having a special service for the customers that are considered as most important for the company, a key supplier status can be obtained. This since Amring can create a situation where the customer becomes more dependent on Amring as a supplier, thus can also the sales be increased. However, Amring still need to be able to deliver what the customer expects. Before, differentiation has been much about to differentiate through price, but this has changed to instead create differentiation through value to the customer. A way for Amring to create value to the customer is to differentiate their service, which their competitors not yet accommodate. Price actually shows the weakest potential for differentiation, and Amring should therefore differentiate through service that creates value over price, or a combination of both. If Amring creates a superior customer value that could in itself be key to their long-term survival and success. To create value through service for the customer could take its shape in a new way of doing business. It is here proposed that such creation of value could take its form

through a new way of having a relationship together with the larger customers. It is proposed that Amring should look into how deeper collaboration through joint planning and replenishment of the customer inventory could take its form. By doing so, they have created a situation where they have a new service to the customer, which could both beneficial for the customer and for Amring.

5.3.1 Customer service differentiation

It is of importance for Amring to find a new type of service that will create an additional value creation for customers, which not only will improve the service but also will improve the results for Amring. As of today, the company quite well know which their largest customers are, but have no specific service that they use for them. By finding a new way of creating value and service to customers, Amring can create a situation where they may look more attractive to new customers and by doing so, increase sales.

It's suggested for Amring to start work with a service differentiation in collaboration with customers in the surroundings, which have the ability to influence Amring's results the most, a customer that is considered to have good knowledge of the market and that they have a good contact with currently. After interviews were held, it was clear that Amring had a customer that matched the criteria well. It was also considered good since the customer concerned were interested in the idea of a deeper collaboration and a differentiation in service specifications. This was also considered good since for the new service to work well, it will be up to the customer to implement new work tasks and break the normal work patterns.

Amring currently has good contact with many of their customers due to their continuously sales meetings in the field. The problem that has been identified in this study is that the cooperation does not extend longer than joint planning for preseason orders planned for next year. There are thus no common forecasts done together, there are no shared points of sales data and the inventory levels of Amring's customers are not known. This information could be valuable for the company since it can improve the problems they currently have with a forecast accuracy and inventory levels that need to be decreased. The lack of collaborative planning has a significant impact on the company's supply chain performance, and Amring's supply chain need to be improved with more accurate information to improve the planning targets. A method addressing many emerged problems where focus has been for this study is collaborative planning, forecasting and replenishment (CPFR). The method of CPFR improves the barriers such as lack of an integrated supply chain and to improve the visibility and get real time demand from customers. The suggestion for Amring is to embrace the parts of the method that most likely result in the greatest benefits for the company. By using the ideas in such method, a deeper collaboration between Amring and its customers where the planning is made on a joint basis would be developed. Amring should in that case create joint forecasts and they should have clear visibility into the company´s inventory levels so they can be able to control and refill them in an appropriate way.

Amring should increase the cooperation with their large customers to extend the joint planning of the forecast. They should not only focus on planning joint pre-season forecast with customers, but instead also focus on planning which tires that will be in focus throughout the year, instead of only, as mentioned, the preseason tires and rims. Throughout this project it has also been found that information accuracy can be improved. It is therefore proposed that they should look further into how point of sales information to end-customers could be obtained through their largest dealers instead of only information about sales numbers to the

dealers. What has also been found is that they could increase control of customer's inventories, and themselves together with customers decide upon which tires that should be in the customer's inventories. By doing so, they could obtain new information and have better control of the customer's inventory levels. All in all with such method, the aim would be an extended joint planning, which is considered good for both parts. What in this project is suggested for Amring is to examine further how CPFR could help them in their daily operations, and which parts that could be most beneficial for them to use from such method.

By using CPFR companies seek the cooperative management of inventories by having a joint visibility and replenishment of products throughout the supply chain. This would in practice for Amring mean that they will control the inventory levels for Customer A, and decide when it will be replenished instead of waiting for orders from the customer. This could improve their own inventory levels at the same time as it improves the collaboration and knowledge of the customer. The method is based on trust between the partners involved, and therefore believed that Customer A will be a good choice due to the fact that they seem to have a good contact with each other already and that Amring currently is a large supplier of goods for the customer. The customer is also open for the idea of using inventory and perhaps increases the inventory levels. The replenishment part of the method means that Amring will use the VMI method, vendor managed inventory. This is a part of the CPFR method, stands for the replenishment part, and thus VMI is not presented as the only option for Amring to use, but one of many inside the CPFR method.

The most important reason, and why it is also proposed to use parts of the CPFR method for Amring, is that the method makes it possible to significantly improve the information that decisions are based upon. It creates a situation for Amring to develop a demand driven supply chain, where more information can be obtained, create additional value to the customer and differentiate the service towards their competitors. As previously mentioned, many of the pros with using such a method addresses the needs that Amring has right now. The accuracy of the company's forecast is something that they have faced problems with over the years. The accuracy of the forecast can be improved by using CPFR since Amring and their customers will work much closer and Amring will get additional information that they didn't have possession of before. They will also create forecast together, and since the two parts are in possession of different information and different knowledge, a joint forecast can create extra robustness and an important extra input for Amring's forecast over next year sells. Customer A would if this method were used make their POS-data available for Amring who then could consolidate this information as a monthly pattern in comparison with the previous year and, based on that, try to predict how the upcoming month of sales will look like.

CPFR to improve internal collaboration

Some of the largest problems or issues detected throughout this study for Amring has been too much tied up capital in inventory, information accuracy can be improved as well as forecast accuracy and costs could be lower. Due to the problems mentioned, a method is suggested that has been considered to be the best choice for Amring since it in the best way addresses the problems just mentioned, as well as it leads to a situation where Amring will in a good way differentiate their service from other competitors.

Amring should start to improve the service towards some of their largest customers. This due to the fact that these customers have the ability to affect their business the most, and also since these has the possibility to be financially strong and thus have the ability for new investments. The possibility to differentiate the service may also in the long run lead to a key

supplier status for Amring with these customers, which in a great way improve sales numbers as well.

Stated quite wide, CPFR will for Amring mean that the collaboration with customers will be much deeper than before, and much of the work will be done jointly, rather than separately as it was done before. According to Barratt and Oliviera (2001) some of the largest benefits by using the method are reduced costs, improved accuracy of information, increased customer service and reduced over stocks. All these benefits are areas that are considered to be highly important to improve for Amring. One of the problems that Amring is currently has according to this study is information accuracy. One of the largest reasons why it is suggested to implement CPFR is that point of sales data with the customer can be shared. If Amring is in possession of such data, they will in a new way be able to see the real time demand from the customer and not just what has been sold from their inventory shelves. The risk with that, as has happened before, is that forecast is based on the sold items, which can have been sold due to reasons such as promotions to get rid of the tire or the fact that they are old and also need to be sold due to that. It's not sure that they see the reason for these large sells, and thus can forecast the item wrongly for next year on the ground that it simply looks like a big sale, and that it is a "good" selling product. But with the help from real sales data, it will be possible to see what the customer sells, and perhaps this won't go hand in hand with the sales from their own shelves. This combined with the aforementioned improved ABC categorization can enhance the ability to make an improved forecast. They can also with a new service differentiation enhance key supplier status, which is considered important since they have a negative sales spiral.

The basis of such method is considered to be the development of a joint planning of the forecast and which products to focus on in the upcoming period of time. Amring will therefore in a new way have the possibility to increase cooperation with customers, use their knowledge, and use their needs, to in a new way understand what they want and together plan after that. It is believed that this can improve their forecast since they will have a new way of getting information from the customers.

This study also suggests that Amring should evaluate the possibility for them to control inventory levels and be responsible for the replenishment of the customer's inventories. This is the replenishment part of the CPFR method, but it is often more known as VMI, vendor managed inventory. It means that information from customers will be shared to Amring, and Amring will have the responsibility of replenishment of their inventories when they see that the stocks are too low. In this business, inventories at customers aren't often very large. It is suggested that Amring target products out of the new ABC-categorization, into the customers own inventories. What this means is that Amring should discuss with customers which products they want, and present which products, out from ABC, that Amring believes should be included on the customers inventories. This will vary from customer to customer, and therefore one part in this implementation will also be to examine what products, out from ABC, that is most suitable for different customers. If this is done in a good way, the replenishment part of Amring to their customers can increase fill rate of transports, increase visibility of chain (see the demand better), improve results (due to that the "right" products will be at the customers shelves) and improve end customer satisfaction. Improvement of end customer is due to the fact that the "right" products will always be on hand for the dealers, so that tires can always be shifted right away, at least if it is of the "most used" tires, and not the unusual type of tire. Promotions should

also be planned together, to match this in a new way and thus be able to plan better. It was mentioned during interviews with customers that many of them miss promotions, which were used previously. What is required for this to work well is a relatively long planning period, where Amring together with the customer carefully examine how this could be executed. This include the planning of a common software, the planning of which products are best for each parties to have on stock for the customer, how inventory-levels and the size of the customers inventory could change and how transports could be rendered in another way.

CPFR also addresses the problem with multiple forecasts developed inside the same company (marketing, financing, purchasing and logistics). Since the method contributes to creating possibilities for better collaboration between different departments, it is considered to be a good choice for Amring. As mentioned in *4.6 Internal collaboration and meetings,* the company currently has problems related to collaboration between different departments, and they are in need of more joint meetings where joint planning can be achieved.

By communicating the numbers needed to be purchased and sold during the coming period, a suggestion is to implement daily short meetings to compare forecast and discuss what needs to be sold and purchased of different variants to meet customer demand and sell the items that needs to be sold. As stated in Figure 1 by Crum (2003) it is important to first understand what the customer wants when managing demand. This can more easily be met if there is open communication between departments responsible for the customer side together with the other departments. Ashayen (2006) also states the importance of involving organisations when planning for variations in demand, which further prove the importance of having more joint planning and improve the transparency and communication. But this can sometimes be challenging since different departments have different requirements. By jointly plan replenishment and forecast between seller and buyer, it becomes easier for different departments inside Amring to together put up aims and numbers for the upcoming year. This since the cooperation is deeper and Amring has the ability to provide more input to the customer as to which products that may be good to have next year, based on input from all departments.

Result of customer and service differentiation
This analysis has shown there are good potentials with the suggestions. What Amring needs to focus on is finding customer patterns and to be better on target different tires to different customers, to increase profits. They need to change focus, to not serve all customers, but to instead let small customers (private customers) seek service at larger dealers instead of coming directly to Amring. If this is done, they can have the possibility to reduce cost from order processing since they will have fewer incoming orders. When Amring will increase the joint planning with customers, it can increases the possibility for the company to easier target the right tires to the right customers, thus increase the possibility to improve the result. It is also proposed that Amring should further analyse this method and use the parts that generates the best potential for largest benefits compared to the current situation. To apply the method straight off might be too wide, since CPFR is a concept including many different parts. By using the parts of the method that creates opportunities for improved forecasting, improves knowledge about customers, improve information accuracy, and should absolutely be reviewed.

5.3.2 Replenishment strategy during high season

The transports from Amring to customers have been analysed and it has been found that Amring can change the way that transports today are carried out. Today, they have a very flexible transport schedule and offer very short lead-times. According to Customer A it could be of

interest to instead work with fewer delivery days each week, at least during high season. This due to the fact that it will reduce costs since they don't have to pay for larger deliveries and also it will increase the unloading time for each occasion but it will still be improved since there won't be as many unloading occasions, which according to Customer A is advantageously. According to benchmark, the least important thing was speed of deliveries, which is an additional reason for prioritising this issue. This will increase the fill rate, reduce the number of transports per week and lead to a situation where both customer and Amring can plan better in advance if many orders are collected and delivered during three or four specific days during week. As was seen in Figure 15 in *2.7 Customers and benchmark with competitors*, savings of 18% per shipment can be done if reducing the number of transports from 2 to 1 and increase the fill rate. Indications of when the transport needs to run can be set after the following two suggestions:

- When the fill rate is exceeding a specific limit, independently on a specific day
- Time limit with deliveries on specific days, e.g. deliveries on Monday, Tuesday, Thursday and Fridays independently on the fill rate

The following suggestions need to be discussed with the customer in order to find the best solution adapted to their situation. If the second suggestion is applied, there can be a reduction both in number of runs but also increase in fill rate during the specific period. In addition the environmental impact will also be decreased which perhaps won't affect their result but is something that will look attractive for investors and potential new customers.

6. Conclusions

This chapter summarizes the main findings from the study and connect to the research questions to make sure the purpose of the study has been met.

RQ1: What are the weaknesses in Amring's current supply chain performance that result in unnecessary high costs?

It has through analysis of empirical findings been identified that Amring lack methods of how to manage their inventory and planning methods to forecast the demand. This has led to weaknesses in their current supply chain performance and resulted in unnecessary high tied up capital in their warehouse. Lacking strategies of how to manage the demand and inventory levels has put them in a situation with high tied up capital, mismatch between purchased and sold quantities, scrap in inventory and low control of which items that should be placed in inventory during certain periods due to the fact that they are lacking differentiation and segmentation strategies. The risk of backlog and risk of loosing customers are additional results of their lack of planning. Using a strategy based on gut feeling for sales and purchases has led to unnecessary high costs and a bad performance of their current supply chain.

RQ2: Which inventory- and demand management strategies can be used to prevent unnecessary high costs and increase Amring's current performance? RQ3: What potential results can be obtained for Amring with the new inventory- and demand management strategies?

This study has developed three main strategies for Amring to address the areas of concern raised in the first research question. It is believed that by implementing these three strategies, including the underlying ideas of the strategies, this can affect their performance in a very positive way.

Inventory management strategy with EOQ, SS and ROP
As how it looks today for Amring, the company has not had a method to control how purchases is carried out in an optimal way. They have lacked a clear inventory management strategy. This in respect of all the costs involved in purchasing products and the costs involved in stocking products. The purchases have been made to a greater extent on what they need right now, and an estimation of future need has been based on gut feeling, thus the quantities have not been planned along the costs they possess. This study proposes a method that better addresses all of the costs included when purchasing and stocking tires and rims for Amring. It helps to create guidelines on how the EOQ is investigated and therefore contributes to a better understanding of which quantities to purchase. Amring have faced problems with lower profits and unnecessary high tied up capital, and by a better understanding of costs that optimizes the purchase, stock volumes can be improved and thus can also the results be improved.

In parallel with EOQ the safety stock levels that follow the items yearly demand should be implemented. This helps with necessary guidelines for how the inventory levels should be carried out so that Amring will always be able to deliver and at the same time avoid risk of backlog. The implementation of safety stock also lead to indications on optimal inventory levels during the year and creates better control for Amring, this since the safety stock is changed throughout the year.

The introduction of ROP also creates a situation of reducing the risk of too much goods in stock. This due to the fact that Amring will get indications from the ROP when the next coming order should be placed to avoid stock outs or too large stock, and make sure the items will be

replenished to avoid such issues. The suggested methods have been analysed based on four representative items supplied from Europe, with relatively stable demand during some periods of the year. This to see if there were any improvements and reductions in inventory levels, costs and a smoother demand compared to 2015 and the method of using the gut feeling. The results of implementing EOQ, SS and ROP is a reduction in inventory levels and also a more smooth way of placing orders that will recue the peaks in purchase as they currently face problems with, for all four items. In addition to this, it will also reduce the total amount of purchased quantities during the year. With this method, there will be a lower risk of the human factor and the risk of estimating wrongly will also decrease.

For the four items examined in this study, the cost savings were significant. The reduction of costs when implementing the new strategies were between 25-91 % for item 1-3 but for item four in the example, the cost increased with 4%. The reason for this can be derived to the fact that Amring during a long period had zero items in stock in 2015 for item 4, which can indicate that they lost in sales due to inability to supply their customers. The method smoothed out the way of placing orders even for item 4, which indicates that the method is appropriate for all four items that were analysed and thus suitable to use for items supplied from Europe with a lead-time of 14 days. However the methods can still give indications of the optimal order quantities, even if the lead-time from Sweden and Asia are more difficult to manage with this strategy.

Categorisation strategy based on multi criteria approach
As a way to eliminate the problems with large scrap and high tied up capital of unnecessary items a new segmentation strategy based on margin value is purposed. The idea with the segmentation is to base the categorisation on ABC based on Pareto's law out from the margin value, instead of solely considering the volume value. Using a multi criteria approach gives a better indication of the importance of the item, where an AA item is the ones that are most important both out from volume and margin, and a CA item indicates that the margin is large but the volume is low, and thus is more important than Amring previously had realised for their profit. This will change the way of prioritising the items. It will also give indications of the value of the items and therefore makes it obvious what items should be stored and which should be eliminated. Using this approach makes it easier to improve the margins and focus on the most valuable item. The result when applying this was 11% of their items sold in 2014 generated a negative margin, and was ranked as D. It also gave indications of which A-margin items that further should be in focus, and which need a change in price strategy. This will improve the supply chain performance and lead to a better strategy for the items that in turn result in increased profit and reduced inventory levels.

Improved planning of demand uncertainty by increased customer knowledge
Since Amring face problems with high tied up capital and base their forecast on gut feeling a strategy of segmenting customers to benefit from their inventories and point of sales data can decrease the problems they have. It is not believed that Amring is using any clear strategy on how to differentiate their service to customers. This study proposes to implement collaborative planning, forecasting and replenishment (CPFR), which address many of the issues Amring is facing. The main issue the strategy addresses is the potential of increasing the knowledge about what specific customers want and what they are actually selling each year. The method will bring the possibility of getting point of sales data, which Amring is currently not in possession of. This will show what the customer actually sold during the year, which can improve the accuracy of the forecast which in itself leads to a better opportunity to understand which products that should be stocked to be able to both improve the forecast and reduce inventory

levels. The strategy leads to a situation where deeper collaboration is reached and joint forecasts are made. This will also help Amring creating a more accurate forecast, since it will be made in collaboration with the customer. They will also be responsible of replenishing the customer's inventory, which means fewer products in Arendal and better control over what the customer really want, when they want it and the possibility to deliver in larger quantities at each occasion. A strategy such as this further puts them in a key role as a supplier for the customers, which in the longer run can improve sales and ensure further collaboration with the customers. In connection with the proposed deeper relationship and increased collaboration with CPFR lies a change of how shipments to customers are carried out.

This proposal involves changing transportation from five days to four days, which could lead to a cost reduction of up to 18 % per shipment, and an environmental impact, which will also be decreased. In addition it is also proposed that Amring moves towards only serving dealers and not offer their service to all customers. This since a large number of their current customers is private customers who purchases small amounts of tires during each year. It would be beneficial for the company if these customers instead turned to dealers. This would decrease the workload for Amring since these orders may instead come together with other orders from larger dealers. In total the strategy will improve forecast accuracy, possible increased sales, improved inventory, better understanding of customer needs and increased possibilities of valuable input from customers.

The suggested implementations and strategies all address problems and unnecessary costs that had been identified as major problems for Amring in their current supply chain. It has been proved that new strategies and methods can reduce their costs significantly and improve their overall performance, which was the overall aim of the study.

7. Generalisation of study

This chapter contributes with a deeper understanding of how the results from the study can be applied in other contexts.

The main findings from the study are that using methods adapted to the contexts and characteristics, by first identifying areas where there are indications of problems, one can improve the supply chain performance significantly. This by introducing approaches and strategies that increases the control. The study has proved that the inventory levels, costs, information accuracy and collaboration can be improved if evaluating the current state based on the method in this study. Since the method used is not adapted to any specific industry, the method can be used despite area of study. The results have in addition proved that strategies such as EOQ, SS and ROP for managing inventory levels are applicable in industries with a relatively stable demand or that the demand is possible to split to become stable during certain periods. It also proves that if managing a large number of customers, it is useful to segment and differentiate the service to engage in deeper collaboration, POS and replenishing the customer's inventory. The last strategy of multi criteria approach result in a better control of the items and their margins, and how much they contributes to the profit of a company (Table 11).

It should be stated that this study, and the suggestions presented, requires that historical data can be obtained. None of these suggestions are possible to develop if there is not historical data on hand. Thus, such methods are not applicable for start-up companies or for new products.

Table 11. General impact of the study

Suggested improvement strategies	**General contributions**
Inventory management strategy with EOQ, SS and ROP	Method suitable to use to decrease tied up capital and improve planning of inventory and optimal order quantities. Shows that a method can contribute to reduced inventory levels and costs compared to if no method is used for the planning of demand and purchase orders. SS and ROP contribute with reduced risk of backlog and optimal inventory levels during different periods. The methods can be applied to industries and supply chains similar in demand variations.
Inventory management strategy with multi criteria approach for segmenting items	Applied to increase awareness of the items and detect the least and most valuable ones that result in large profit and margins. The approach can be used to improve pricing strategy and reduce scrap. It is proved that inventory control is increased and scrap can strategically be evaluated and reduced. The margin simplifies planning for future sales and which items to focus on. A general approach that suits all industries.

Demand planning with sharing of data from customer and collaboration through CPFR and POS	A way to improve the data sharing and reduce tied up capital is to implement CPFR with large customers. The implementation proves that shipments can be reduced and more accurate data used for forecast to reduce bullwhip effect, despite industry or supply chain

8. Discussion and further recommendations

This chapter includes a discussion about the findings from the analysis and suggestions for further research of the area and recommendations to the company. Difficulties as well as areas that possibly can be improved are discussed here as well. It ends up with a discussion of risks that are connected to the new strategies.

The two thesis writers that conducted this study at Amring did not have any previous experience from tire businesses and the project was thus constructed in a rather objective manner. All collected data was obtained through interviews, observations and discussions with representatives from the case company, which therefore can have been evaluated from an external point of view. This might represent the same view as the suppliers, customers and other stakeholders have of Amring, which makes the analysis interesting from a management point of view. The combination of academic input from the writers and deep knowledge about the tire business from the research study company created a valuable input for the result of this study.

8.1 Further recommendations of the study

To obtain a holistic view of the whole supply chain, the areas out of scope should be evaluated to make sure improvement areas regarding the whole supply chain are covered. A further recommendation is therefore to investigate and evaluate the supplier side, and the external parties and actors as well as the employees on shop floor level, by using the same methods provided in the report.

The study could be more robust if an evaluation of the suggested improvements had been evaluated after the implementation of the new strategies. This to be able to find relevant KPI's to further see how the performance is improved through various measurements.

It has been left for further studies to investigate whether or not the pilot project of CPFR will be taken further. In accordance to the theoretical framework and analysis, a suggestion of how the new strategy could be applied has been made without further evaluation. In addition, the robustness of the result could be increased if more customers would have been included in the study. The method suggested is the one showing most possibilities to improve their current situation, but further examination should be made to see if this method is the one creating the best situation for the case company. Especially with regards to the fact that investments need to be made on new IT-system, and further evaluation need to be put on how costly this could be and to which extent customers are willing to invest. This should be a priority for Amring to look closer at, since their results have been declining and therefore potential for investments may be restricted. It is also recommended to the case company to examine which part of the method presented that has the best possibility to create value for them today.

When conducting the inventory management analysis, four items were used as representative examples throughout the study. However, only evaluating four items do not indicate that this method is preferably used for all items managed in the inventory, but for a specific segment of items supplied from Europe with periods of relatively stable demand. The method applied proves that it is a useful way of finding the optimal order quantity in order to reduce costs compared to data used from 2015. If additional data gathered from 2014 and 2013 were used, the result could have been more robust. A recommendation is therefore to compare the calculated numbers with a calculation of previous years as well to see if the result might be more accurate.

8.2 Recommendations to case company

The interviews and discussions obtained with the representatives might have influenced the direction of the study and the focus areas. This due to the fact that different employees at the company were more involved in the study than others, and the evaluation might have been directed by their showed interest. It is therefore of interest to recommend the company to evaluate more respondents within the company, from shop floor and even outside the company to increase the robustness of identified improvement areas.

The multi criteria approach might include other indications than volume and margin value. Further investigations of such categories can be done to improve the approach further. Example of categories to evaluate can be lead-time or size of the item, to broaden the range of factors. This approach might be useful when connecting to the service level of the items that further needs to be investigated within the warehouse location.

There are other areas that have been left for further studies that during analysis were ranked as second order of prioritisation. Due to the limitation of the study, the areas have been summarized in Appendix F and are left for further recommendations to the case company to study.

8.3 Risk analysis of the suggested improvements

If the new value based categorisation is not shared in the Visma system used today by Amring and shared among all employees, there is a risk that one department is relying on the new categorisation but another is having a focus based on the previous categorisation, which is misguiding and could be risky. In the analysis of the split between categories, items that generated a margin that departed in one way or another due to some motivated reason have not been considered. There might be a risk that some items do not include all data representative for the purchase price and sales price when conducting the ABC analysis, due to limited access to updated data from 2014 and 2015.

The risk of calculating the EOQ value based on an uncertain demand for different periods might result in a risk of misguiding numbers to rely on. Therefore, the items where the method of EOQ has been obtained in this study has been carefully been evaluated. However, for items with uncertain demand, the method can give guidelines of the optimal quantity, even if the method should not be followed strictly. The risk of only relying on theoretical number is an additional risk that must be evaluated. As an example of this, some suppliers might not accept the orders to be placed in accordance to the EOQ value, since they require a container or a car to be filled before shipping for instance. However, the calculated quantities to be shipped in each batch are optimised, and compared to before when very small quantities were shipped, the new calculations might not be affected by the constrains of suppliers.

The risk of implementing the idea of CPFR on one customer might be that this customer is treated in another way than similar customers that requires the same service. All possible customers have not been evaluated in the study, which should be done before starting to segment to avoid issues related to dissatisfied customers. Since it takes time and cost to build a good relation with a customer, it is important to negotiate a contract that includes all risks that can happen, that is agreed upon by all parties involved. One risk that can occur is who carries the risk of items that are not sold. This negotiation has not been considered and agreed upon. To invest in an integrated IT-system might be costly and there could be a risk that the numbers

of inventory levels are not updated which lead to a situation where Amring replenish the wrong items to their customer since they get wrong indications.

The collaboration both externally but also internally require all employees to be involved on the same basis and that all problems are highlighted in order to avoid misunderstandings that will affect the relations. There could be a risk of personal opinions that lead to a weaker collaboration among some parts than others.

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Appendix A –Questionnaires used during interviews

1. Questioner used for interviews with customers

- How is the collaboration with Amring? Can anything be changed or improved?
- What are Amring's strength and weaknesses as a tire supplier?
- What potentials for improvements do you see at Amring? Is there something you would like to change?
- How is the order page working today? Is there any information missing? Would it be easier for you if the lead-time until the product is replaced would be placed in the order system?
- What do you think about a 48 h lead-time? Is it necessary for you? Could you imagine getting deliveries 2-3 days a week from Amring in larger batches (increased fill-rate) and better plan for when deliveries are supplied to your warehouse?
- Is it possible to use contracts with Amring to improve the relation and collaboration?
- What do you think about campaigns? (Both how you market yourself to your customers and getting reduced price if buying larger batches?)
- What is your typical customer and how do they place their orders?
- What is the most important to you:
    - Short lead-time?
    - Low cost?
    - Close collaboration?
- How does your hotel for the tires work? Is there any possibility that you could offer a service to your customers that includes a change of tires if that's needed? Or is this something that you have right now?
- Does it happen often that you have to turn to someone other than Amring when ordering tires and rims? And if so, what is the reason behind that?
- What do you think of the possibilities to increase your warehouse? Is this negotiable, under the circumstances that it will lead to better availability and increase the service level?
- If the warehouse will expand, how do you then look at the possibility that Amring will be in charge of the warehouse to optimize the availability on tires and rimes?
- Do you have any forecasting system or does requests to Amring comes in connection with new orders from your customers? And how often are these orders put? Daily? At a specific time? Etc.

- What do you think of the possibility that Amring will have access to your information/data, to be able to improve planning and at the same time improve deliveries?

- How would it affect you if there were fewer models (tires and rims) to choose between? Could there be a risk of you looking for other suppliers?

- What initiates a purchase from your side? Is it just customer orders or is it other signals as well? For iinstance special offers.

2. Questioner used for sales-, purchase- and logistics manager separately:

- What is your vision? Long term vs. short term? According to Andreas you have aimed for "one stop shop" to your customers? Is that a good strategy according to you?

- What are you aiming for in the future? Expand with suppliers in Asia? Limit to a specific customer segment etc.?

- Can you please tell us about your supply chain? From start to the end (including manufacturing, transport, inventories etc.)

- What do you strive for with your new supply chain?

- Did you benchmark with other companies in the same business? How are they working, can you learn from them?

- What kind of KPI's are used today? Do you think they are relevant or do you need other measures that match your problems?

- Do you face any problems with the suppliers in Asia or Europe? What are the benefits and drawbacks with these suppliers?

- Did you consider the possibility to control the inventories of your largest customers and plan for their inventories? Like use of VMI?

- What are your largest problems related to costs? How can they be optimised?

- Where in your current supply chain set-up do you feel that there are unnecessary high costs?

- Do you believe that it would help with better forecast from your larger customers and is there a need of this to be improved?

- When introducing the cooperation with Agility, what do you think that Amring can learn from such cooperation? Do you believe that it can open for new ways of store some products in other parts of Europe through for instance a hub? Or in what parts of the supply chain do you believe that you can benefit from this new cooperation, in addition to the in-house logistics part?

- How good is your control over the supply chain? Which updates are given from the point where orders are put to the point when they are in your warehouse?

- How does your supply chain look like for small orders compared to large orders? What do you in general feel about the small orders? How does your forecasting system works, with regards to the fact that purchasing is often done by gut feeling and looking at future sales? Do you believe that you need to improve this part?

- How do your relationships with your supplier's looks like? Is it arm's length or closer relationships?

- What initiates a purchase? Do you use any kind of re-order point system or is it just a gut feeling that initiates the purchase?

- Is a 48 h lead-time good to offer your customers? With regard to the fact that you have so long lead times from Asia?

3. Questioner used for purchaser-, logistics- and sales managers together:

- What do you think are the main problems related to your supply chain today?

- What/where do you see that you have the largest problems now that are purchasing related?

- What is the reason for outsourcing your main operations to Agility?

- Can you explain about your purchasing strategy today?

- Have you evaluated your current supply chain before? What result did you get?

- What is the supply chain related to purchasing look like? Where do you have inventories and for how long are the products/batches in the inventory?

- How do you think the cooperation between purchasing and sales is working?

- What kinds of transport modes are used? What is the reason for using them (short lead-time/environmental friendly)? What alternatives are there?

- Are the purchases limited, i.e. are there a minimum number of items that needs to be ordered at each occasion? For instance one container. Looks different for different suppliers?

- How are transports purchased and how does the contract look like?

- What are the lead-times and does it match the customer?

- Do you keep the times or do you sometime need express deliveries to cover up? If so, in what expand?

- How does the different product segment looks like? What kind of items does you purchase today?
- How are orders put? How is it planned for? When are they purchased compared to when they are sold?
- Is there any difference between high- and low frequent purchases, regarding contract and amount for example?
- Do you face any problems related to the seasonal variations in demand? When is the biggest problem?
- In which frequencies are orders placed? Daily, weekly…
- How big batches do you purchase? How does the size of the batches look like? What differs between an a-product and a b-product?
- What is the lead-time for each product group?
- Where do you face the biggest problems with high costs, which are the most critical part?
- What is the cost for storage of each product segment and for how long are they stored on average?
- How is the collaboration between suppliers working? Do you have any chance to affect them in any way? Who has the power?
- What kind of relation do you have with your suppliers? Arms length/close/contract? Different?
- In which continents are your suppliers located?
- Are the purchases limited, i.e. are there a minimum number of items that needs to be ordered at each occasion? For instance one container. Looks different for different suppliers?
- What do you aim for with the new supply chain? For instance shorter lead-times, cost savings etc.?
- What is your short term and long-term visions?
- Do you have any critical success factors?
- What kind of KPI's are measured? Are they good/bad? Can we use them to see how it has developed?

Appendix B – State in 2015 of item 1-4, demand, purchases and inventory levels

Inventory levels have been calculated based on the level from previous month. The difference in purchased and demand quantities are added to get the inventory level for the next coming period. Ex:

Purchased quantities: X

Demand: Y

Inventory level in May=Z

Inventory level in June= Z+X-Y

Item 1	2015	2015	Inventory level 2015
	Purchase	Demand	161
January	0	41	120
February	0	25	95
March	0	13	82
April	0	29	53
May	0	5	48
June	0	4	44
July	0	1	43
August	300	12	331
September	500	170	661
October	0	159	502
November	0	102	400
December	0	42	**358**
	800	603	

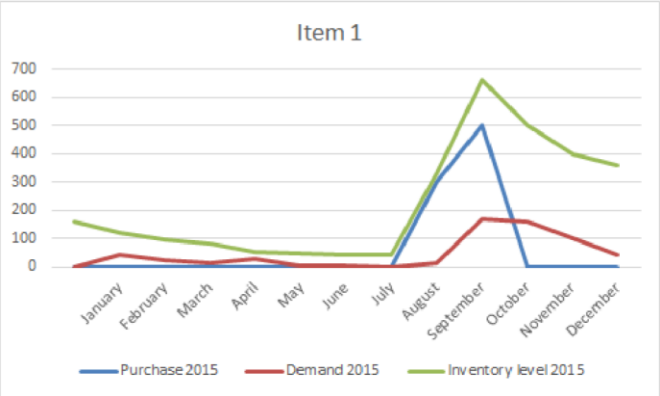

Figure 24. Purchase vs. demand and inventory level of item 1 in 2015

Item 2	2015	2015	Inventory level 2015
	Purchase	Demand	5
January	0	0	5
February	2020	324	1701
March	400	1593	508
April	2174	1566	1116
May	0	432	684
June	200	497	387
July	300	472	215
August	80	275	20
September	120	120	20
October	60	32	48
November	0	48	0
December	0	0	**0**
	5354	5359	

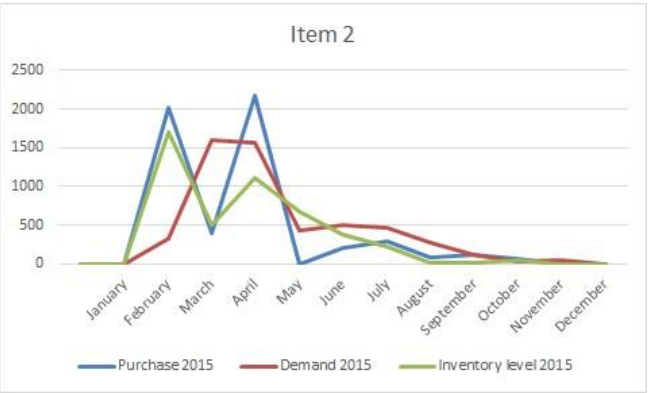

Figure 25. Purchase vs. demand and inventory level of item 2 in 2015

Item 3	2015	2015	Inventory level 2015
	Purchase	Demand	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	36	12	24
June	348	72	300
July	471	32	739
August	429	26	1142
September	0	70	1072
October	246	144	1174
November	200	125	1249
December	0	48	1201
	1730	529	

Figure 26. Purchase vs. demand and inventory level of item 3 in 2015

Item 4	2015	2015	Inventory level 2015
	Purchase	Demand	24
January	0	0	24
February	48	2	70
March	542	258	354
April	70	303	121
May	0	66	55
June	0	24	31
July	0	13	18
August	1	19	0
September	4	4	0
October	0	0	0
November	0	0	0
December	0	0	0
	665	689	

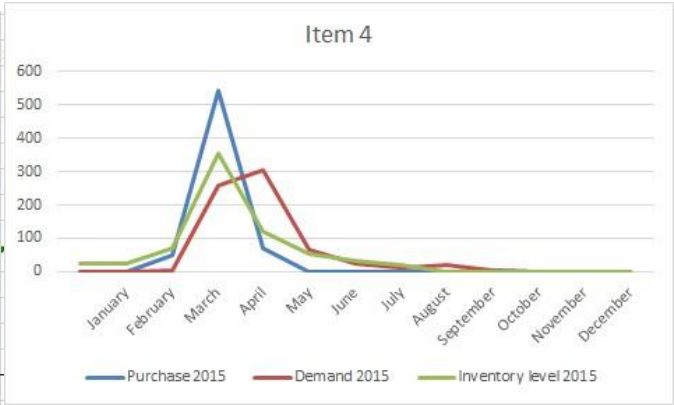

Figure 27. Purchase vs. demand and inventory level of item 4 in 2015

Appendix C - Cost calculations for items in inventory

Based on numbers given by the logistics manager, the costs per item have been estimated for the warehouse in Arendal.

The total cost of tires is calculated based on the fact that each cost per item includes not only the storage place that it need in the warehouse, but also additional space cost for the space in between the shelves. Therefore the total cost in this study for holding tires in inventory is assumed to be the total warehouse cost per year. This to just get a representative value. It is also assumed that all tires hold the same space in inventory.

Total cost of warehouse per year: 18 000 000 SEK/year

Number of items stored per year: 600 000 items

Cost per item per year: 18 000 000/600 000=30 SEK/year

This gives a total cost per month per tire of: 30/12=2, 50 SEK/tire/month

For item 1-5 (Appendix A), the following costs have been calculated based on the inventory levels during 2015:

Item 1:
Items in inventory 2015: 2737 items/year

Inventory cost: 2737*2, 5 SEK= 6843 SEK/year

Item 2:
Items in inventory 2015: 4704 items/year

Inventory cost: 4704*2, 5 SEK=11760 SEK/year

Item 3:
Items in inventory: 6901 items/year

Inventory cost: 6901*2, 5 SEK=17253 SEK/year

Item 4:
Items in inventory: 673 items/year

Inventory cost: 673*2, 5 SEK=1683 SEK/year

Appendix D - Calculation of ordering costs and handling costs used in EOQ

Ordering costs:
According to Mattsson (2003), the order placement cost can include parameters presented in Table 1. When applying this on Amring, the following cost parameters have been identified:

Factor 9-13 in Table 1:
Ordering costs are calculated based on the factors presented in Table 1. In total, it requires 1.5 working hours to empty a container performed by four people that costs 250 SEK/hour. This means that it costs 1.5*250*4=1500 SEK to empty one container. In addition it requires 1 hour of one employee to place the items in the shelves, which costs 250 SEK in addition. Adding this to the calculated value gives: 1500 SEK+250 SEK=1750 SEK in handling costs to empty one container. It is estimated that each container in average is filled with 1000 tires, which means it costs 1750 SEK/1000=1,75 SEK/item and there are in total 220 items per order which indicates that 1000/220=4,45 order per container is handled. This gives an estimated value of the handling cost per order which is: 1750 SEK/4,45=**393 SEK/order**

Factor 14-15 Table 1:
Cost of payment and invoice control is estimated to be 500 invoices per month managed by one employee that costs 45000 SEK/month. This gives an estimated value of 45000/500=90 SEK/month for invoice and payment costs. It is estimated that each invoice contains in average 100 items, which gives a value of 0,9 SEK/item. Since it is estimated that each order contain 220 items, the cost for this is: 0,9*220=**198 SEK/order**
Cost for invoice per order is: 20 containers times 4 gives the number of containers handled each month= 80. Small deliveries are estimated to be 10 per day, in addition to the containers. This result in approximately 500 invoices per month for all of these deliveries in mixed quantities. This number times 1 employee for managing all invoices*45000/500 gives **90 SEK per invoice per order**

Factor 4-7 Table 1:
It is assumed that it costs 1 SEK/item to manage the purchase of a new order. This multiplied by the number of items on each order, which is 220 SEK/order, gives a cost of **220 SEK/order** for factors 4-7.
Costs for external transportations have been estimated based on the total shipping costs per year, where the average of this per order is assumed to be representative for the whole year. This gives: 4050000 SEK for shipping costs, and it gives when splitting it by the number of orders: 4050000 SEK/(6000 orders)=**675 SEK/order**

Total order handling cost: 675+220+90+198+393=**1576 SEK/order**

Inventory handling costs:
The calculations are based on the numbers that will start from the time Agility is going to manage half of the warehouse. The finance manager gives these numbers and logistics manager and some are estimated values based on the given information. Through calculations, the estimated inventory handling cost is as follows:

- Rent of warehouse: 70,66 SEK per square meter and month (--> 11000*70,66*12=9,3 MSEK/year)
- Cost for employees: 10 MSEK/year

- Amortization of storage racks: 2843000/2=1,2 MSEK per year
- Cost for leasing trucks: 1,6 MSEK/year
- Overhead costs: 1,6 MSEK

This results in total: 1,6+1,6+1,2+9,3+10=**23,7 MSEK**

According to the logistics manager the total value of the tied up capital in the warehouse is: **120 MSEK**

The holding cost factor is calculated: (1,6+1,2+9,3+10+1,6)/120 MSEK=0,1975 → **19,75%**

Appendix E - Result from analysis of EOQ, SS and ROP item 1-4.

Item 1

Item 1	Purchase 2015	Demand 2015	Inventory level 2015					EOQ	Inventory level EOQ								
	Purchase	Demand	161	Safetystock	EOQ	Reorder point		Purchase	0	Average demand	sigma	Service level 98%	D*LT	Price	Order cost	Inventory handling cost
January	0	41	120	10	25	25	3*EOQ	76	35	30	5	2,05	15	748,93	1576	0,195
February	0	25	95	10	25	25		0	36	30	5	2,05	15	748,93	1576	0,195
March	0	13	82	10	25	25	EOQ	25	48	30	5	2,05	15	748,93	1576	0,195
April	0	29	53	10	25	25	2*EOQ	51	19	30	5	2,05	15	748,93	1576	0,195
May	0	5	48	2	8	4		0	14	3	1	2,05	2	748,93	1576	0,195
June	0	4	44	2	8	4		0	10	3	1	2,05	2	748,93	1576	0,195
July	0	1	43	2	8	4		0	35	3	1	2,05	2	748,93	1576	0,195
August	300	12	331	10	25	25		0	78	30	5	2,05	15	748,93	1576	0,195
September	500	170	661	35	56	107	5*EOQ	278	131	144	17	2,05	72	748,93	1576	0,195
October	0	159	502	35	56	107	2*EOQ	111	139	144	17	2,05	72	748,93	1576	0,195
November	0	102	400	35	56	107	2*EOQ	111	63	144	17	2,05	72	748,93	1576	0,195
December	0	42	**358**	10	25	25		0	**21**	30	5	2,05	15	748,93	1576	0,195
	800	603	2898					654	630							

Figure 28. Item 1, numbers used for calculating EOQ, SS and ROP

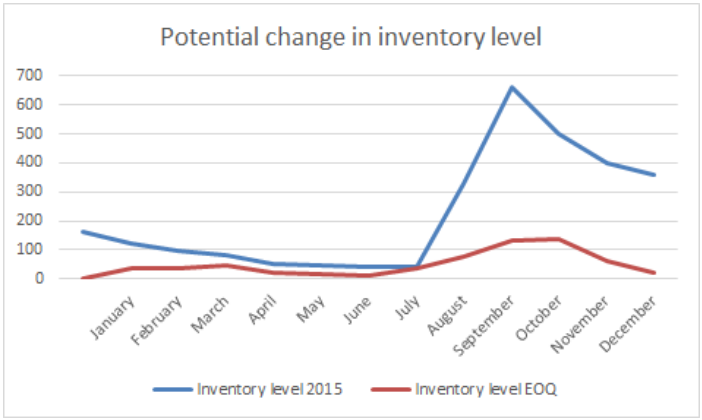

Figure 29. Potential reduction in inventory level for item 1 compared to 2015

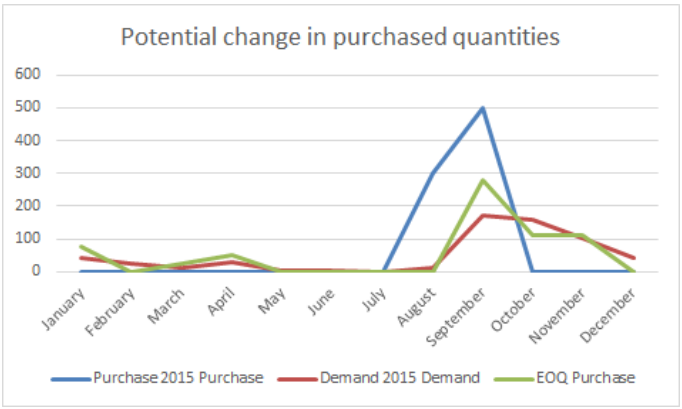

Figure 30. Item 1, potential reduction in purchased quantities compared to 2015

Costs 2015	Costs after EOQ
300	88
238	89
205	121
133	48
120	36
110	26
108	87
828	196
1653	328
1255	348
1000	156
895	51
6843	1574

Figure 31. Potential inventory costs in 2015 (SEK) of item 1 compared to implementation of EOQ, SS and ROP

Item 2

Item 2	Purchase 2015	Demand 2015	Inventory level 2015					EOQ	Inventory level EOQ								
	Purchase	Demand	5	Safetystock	EOQ	Reorder point		Purchase	0	Average demand	sigma	Service level 98%	D*LT	Price	Order cost	Inventory handling cost(%)
January	0	0	5	0	0	0	2EOQ	293	293	0	0	2,05	0	300,51	1576	0,195
February	2020	324	1701	75	147	275	2 eoq	583	552	400	37	2,05	200	300,51	1576	0,195
March	400	1533	508	20	291	809	7eoq	2040	1000	1580	10	2,05	790	300,51	1576	0,195
April	2174	1566	1116	20	291	809	6eoq	880	314	1580	10	2,05	790	300,51	1576	0,195
May	0	432	684	75	147	275	3eoq	440	322	400	37	2,05	200	300,51	1576	0,195
June	200	497	387	75	147	275	4eoq	587	412	400	37	2,05	200	300,51	1576	0,195
July	300	472	215	75	147	275	3eoq	440	380	400	37	2,05	200	300,51	1576	0,195
August	80	275	20	75	147	275		0	105	400	37	2,05	200	300,51	1576	0,195
September	120	120	20	12	46	32	eoq	46	31	40	6	2,05	20	300,51	1576	0,195
October	60	32	48	12	46	32	eoq	46	45	40	6	2,05	20	300,51	1576	0,195
November	0	48	0	12	46	32	eoq	46	44	40	6	2,05	20	300,51	1576	0,195
December	0	0	**0**	0	0	0		0	44	0	0	2,05	0	300,51	1576	0,195
	5354	5359	4709					5403	3540							

Figure 32. Item 2 numbers used for calculating EOQ, SS and ROP.

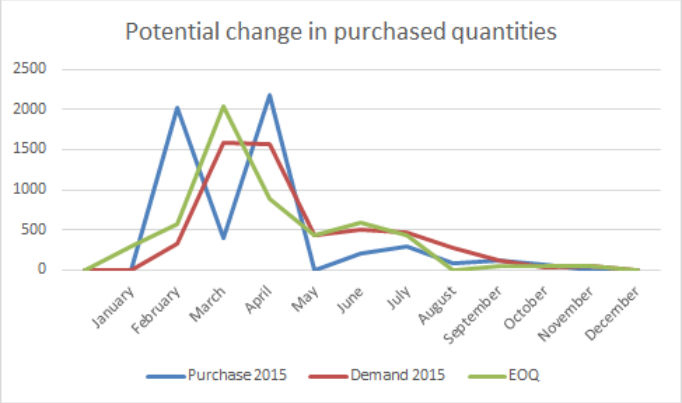

Figure 33. Potential reduction in purchased quantities compared to 2015 of item 2.

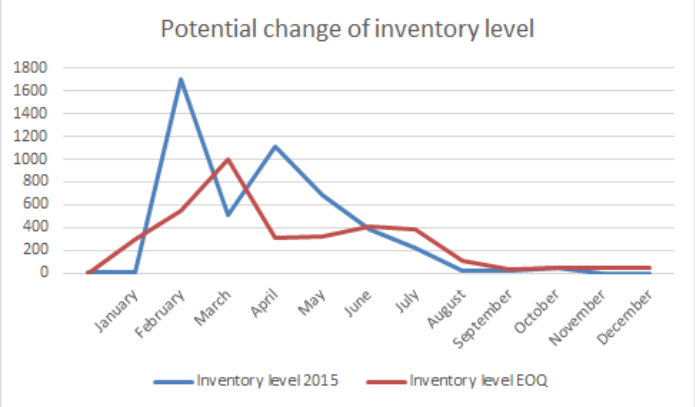

Figure 34. Potential inventory level improvements after implementing EOQ compared to 2015 item 2.

Costs 2015	Costs after EOQ
13	733
4253	1381
1270	2499
2790	784
1710	805
968	1029
538	949
50	261
50	77
120	113
0	109
0	109
11760	8851

Figure 35. Potential improvements in costs for item 2 after implementing EOQ.

Item 3

Item 3	Purchase 2015	Demand 2015	Inventory level 2015					EOQ	Inventory level EOQ							
	Purchase	Demand	0	Safetystock	EOQ	Reorder point		Purchase	0	Average demand	sigma	Service level 98%	D*LT	Price	Order cost	Inventory handling cost(%)
January	0	0	0	0	0	0		0	0	0	0	2,05	0	659,05	1576	0,195
February	0	0	0	0	0	0		0	0	0	0	2,05	0	659,05	1576	0,195
March	0	0	0	0	0	0		0	0	0	0	2,05	0	659,05	1576	0,195
April	0	0	0	0	0	0		0	0	0	0	2,05	0	659,05	1576	0,195
May	36	12	24	19	33	40	3EOQ	98	86	43	9	2,05	22	659,05	1576	0,195
June	348	72	300	19	33	40	3EOQ	98	112	43	9	2,05	22	659,05	1576	0,195
July	471	32	739	19	33	40		0	80	43	9	2,05	22	659,05	1576	0,195
August	429	26	1142	18	33	40	EOQ	33	86	43	9	2,05	22	659,05	1576	0,195
September	0	70	1072	18	33	40	2*EOQ	65	81	43	9	2,05	22	659,05	1576	0,195
October	246	144	1174	14	57	81	4*EOQ	230	110	135	7	2,05	67	659,05	1576	0,195
November	200	125	1249	14	57	81	EOQ	115	42	135	7	2,05	67	659,05	1576	0,195
December	0	48	1201	18	33	40	EOQ	33	**27**	43	9	2,05	22	659,05	1576	0,195
	1730	529	6901					671	623							

Figure 36. Item 3, numbers used for calculating EOQ, SS and ROP.

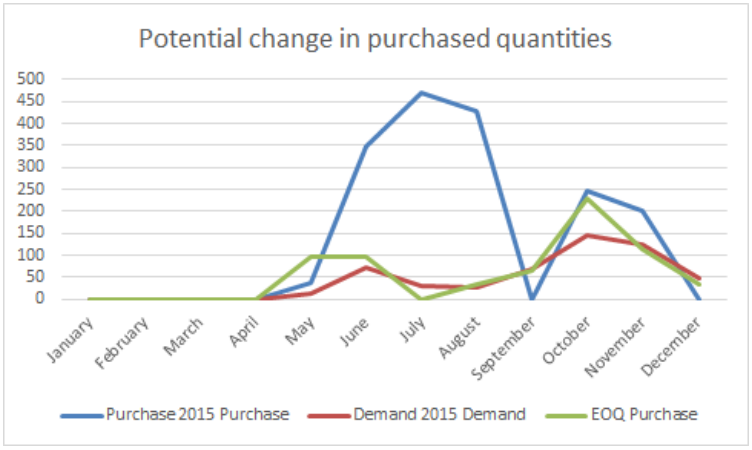

Figure 37. Potential reduction in purchased quantities item 3 after implementation of EOQ item 3

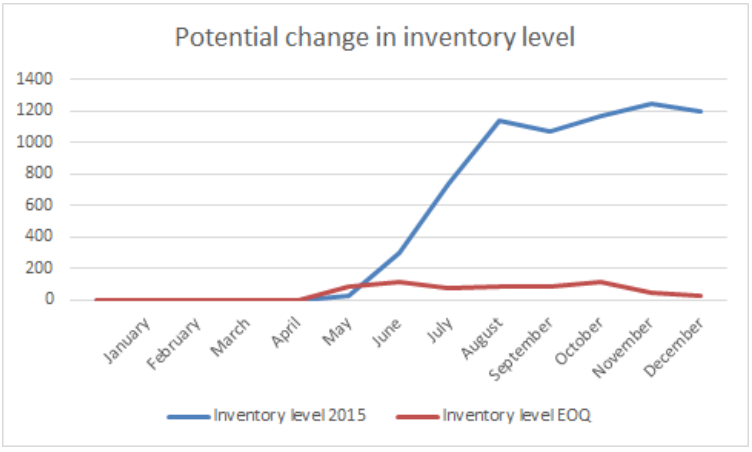

Figure 38. Potential reduction in inventory level after implementing EOQ compared to 2015 item 3

Costs 2015	Costs after EOQ
0	0
0	0
0	0
0	0
60	215
750	279
1848	199
2855	216
2680	204
2935	274
3123	105
3003	67
17253	1558

Figure 39. Potential cost reduction after implementing EOQ, SS, ROP item 3

Item 4

Item 4	Purchase 2015	Demand 201	Inventory level 2015					EOQ	Inventory level EOQ							
	Purchase	Demand	24	Safetystock	EOQ	Reorder point		Purchase	0	Average demand	sigma	Service level 98	D*LT	Price	Order cost	Inventory handling cost
January	0	0	24	0	0	0	EOQ	23	23	0	0	2,05	0	625	1576	0,195
February	48	2	70	20	23	31	2*EOQ	170	192	21	10	2,05	11	625	1576	0,195
March	542	258	354	33	85	173	4*EOQ	341	275	281	16	2,05	140	625	1576	0,195
April	70	303	121	33	85	173	3*EOQ	70	41	281	16	2,05	140	625	1576	0,195
May	0	66	55	20	23	31	3*EOQ	70	45	21	10	2,05	11	625	1576	0,195
June	0	24	31	20	23	31	EOQ	23	45	21	10	2,05	11	625	1576	0,195
July	0	13	18	20	23	31		0	32	21	10	2,05	11	625	1576	0,195
August	1	19	0	20	23	31		0	13	21	10	2,05	11	625	1576	0,195
September	4	4	0	0	0	0		0	9	0	0	2,05	0	625	1576	0,195
October	0	0	0	0	0	0		0	9	0	0	2,05	0	625	1576	0,195
November	0	0	0	0	0	0		0	9	0	0	2,05	0	625	1576	0,195
December	0	0	0	0	0	0		0	**9**	0	0	2,05	0	625	1576	0,195
	665	689	697					698	700							

Figure 40. Item 4 numbers used for calculating EOQ, SS and ROP

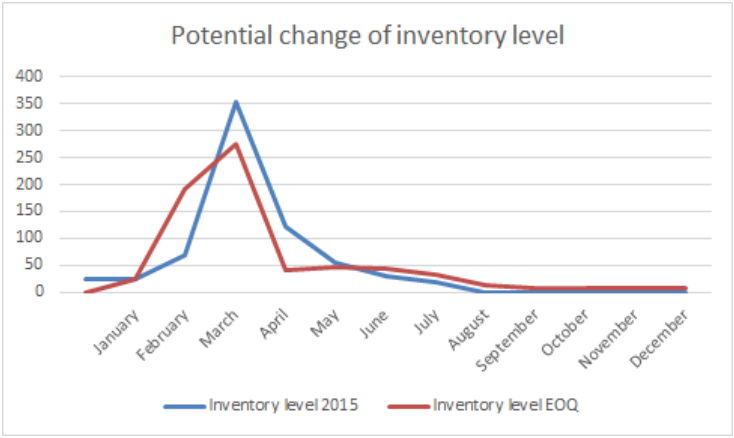

Figure 41. Potential change in inventory levels for item 4 compared to 2015.

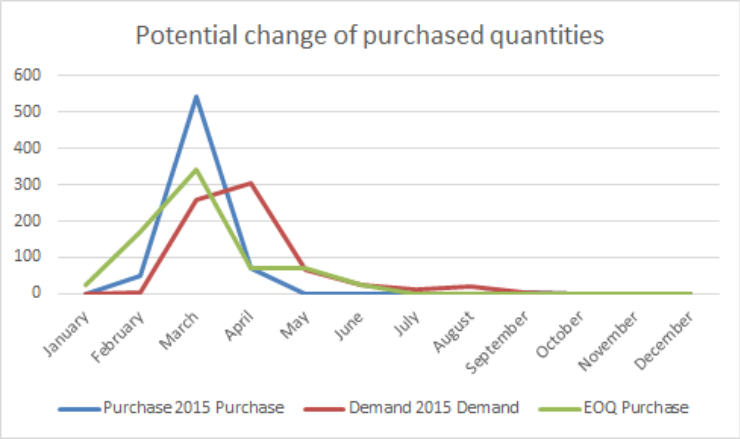

Figure 42. Potential change of purchased quantities of item 4 compared to 2015.

Costs 2015	Costs after EOQ
60	59
175	480
885	686
302,5	104
137,5	113
77,5	112
45	79
0	32
0	22
0	22
0	22
0	22
1682,5	1751

Figure 43. Potential changes in costs for inventory of item 4.

Appendix F - Recommendations to case company for further improvements

Here, the improvements as were prioritised as second order when analysing the findings are summarized and explained in more detail.

Deliver straight from suppliers to customers

As a way to increase the insight in the customer's organisation and warehouse data, it is suggested to start delivering items directly from suppliers to the customer. This might suit for items ranked as C and are delivered less frequent. The starting point for which items should be supplied this way could be the new classification of items presented in the thesis. This means Amring have to manage the transports from supplier, in order to decrease the risk of letting the supplier get insight in Amring's business and customer base. The point here is to let the customer place the order at Amring and get invoice from Amring and Amring get the invoice from supplier.

Web-page improvements

As has been mentioned during the project, information from the web-page should be used more extensively. Today Amring does not collect information about what the customers on the web-page are searching for. This information could be used to better understand if there are tires or rims which customers often search for but Amring is unable to supply due to stock outs. If this information could be collected, it would improve inventory management for instance, since it could lead to a situation where it is easier to understand which tires the customers actually wants. This is called big data and is something which Amring could use more, in regards to their web-page, to obtain more important information.

Further web page improvements might be:

- do not send orders directly when customer place them, make it possible to store the items in a queue on the web page and send the order when the limit of 4 or 8 tires is reached (customers do not always need the short lead time)
- make it easier to navigate without clicking that many times
- add lead time on the web page to make it easier for customer to see when it is back in stock again

Shorten lead time from Asia with a warehouse

One of the largest problems regarding transports and planning is the extreme lead time from Asia, which differs between 3 to at some occasions 5 months. This becomes a large problem since the planning will be extremely difficult. It was also highlighted that there was a lack of control of these shipment. In various occasions they could be late/early, which puts Amring in a difficult situation since there may not be room for storage or if they are late, the season for the tires may be over. An idea is to use Agility to create a possibility to store items in either Asia or Europe after production, to decrease the lead-time of such tires. In addition, Amring should suggest a use of "control tower", which Agility could arrange due to their expertise in logistics. This to improve the control of goods shipped from Asia, since the transit often takes a long time, and there are many checkpoints which can give updated information on arrival time. The long lead-time they have now from Asia often cause large inventories, and they should evaluate to use more of the suppliers from closer markets and target customers into buying European, premium tires instead.

Evaluate further forecasting methods

In addition to the EOQ formula, a statistic tool that takes into consideration all variations that possibly can occur should be implemented. By finding an algorithm for this, it is possible to find the optimal level out from the uncertainties. The risk of it to happen gets a value, and then a calculated amount in the forecast can act as the base when creating the forecast. Since it has been highlighted during the project that EOQ suits most optimal when the demand is relatively stable, a proposal is to also investigate other methods in addition to the one examined during this project. EOQ works very well for some of your products but for others, method such as Silver-meal, exponential smoothing, moving average and Wagner-Within could be evaluated. Amring is in a situation where it's believed that it is hard to implement only one method since the demand looks very different for different products. It is also considered to be of importance to investigate in some sort of planning program in addition to the one used now to improve the accuracy in planning and purchasing, with regards to both costs and turnover rate.

Tire hotels

As an additional way of smoothing out the peak and the demand variations, it is suggested to deepen the use of tire hotels and increase the possibility to gain useful information from them. The further away from the customer one get, the harder it is to understand the real demand, which can be visualised by a bullwhip. By increasing the transparency and deepen and increase the collaboration with customers through CPFR, it is possible to obtain important information from the customer's tire hotels. Many of the large customers are storing between 1000-2000 tires in their hotels, and much more information can be obtained from them than today. As of today, the customers themselves call when they want to change tires, but this can be manage differently. By influencing the end customer to offer a specific appointment especially selected for the customer when to change tires for the next coming season, one can avoid all customers coming at the same time. This makes it easier to plan both for the customers of Amring, Amring and the end customer. By delivering the tires in accordance to which customers are going to change tire during a specific week or day, it makes it easier to have the right items in stock but also avoid high workload during the peak. The peak is usually affected by the weather, and since weather is impossible to forecast, it is of high importance to influence the customer by changing those customer's tires before the peak is coming. By also offering a service of purchasing the tires in beforehand, the customer can freely chose the tire they want in beforehand but pay when the change of tires has been performed. The risk with this implementation is that Amring is still carrying the risk until the tires have been changed. On the other hand, by offering a better service to the customer, it is possible to both smooth out the demand but also make it easier by planning for the customer to actually get the change of tire done. This can also improve the service level by Amring's customers, since the service is increasing to the end customers.

Appendix G – Multi criteria approach with ABC

Improved multi criteria approach with both volume value and margin value. An example provided by Flores & Whybark (1987) that shows how the two categories are suggested to be combined at Amring.

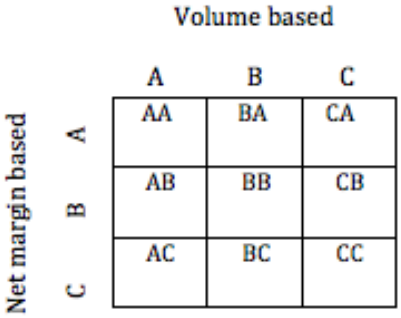

Figure 44. Suggested multi criteria approach