Decision Support System for Warehousing Strategies

Master of Science Thesis

Cecilia Colliander
Anna Tjellander

Textile Management with Specialisation Supply Chain Management
THE SWEDISH SCHOOL OF TEXTILES IN BORÅS
Borås, Sweden, 2013
Report No: 2013.16.1
Abstract

Although distribution and warehousing theory have been extensively studied in terms of optimisation and functional excellence the extension of these concepts into supply chain management has not been fully explored. In addition information at which decision level warehousing strategies are formed is limited. The purpose of this thesis is to investigate which supply chain drivers and subordinate variables that affect warehousing decisions and how these can be used for warehousing strategies. The findings will serve as a decision support in strategic warehouse network design. To fulfil the purpose of the thesis a case study was performed at a sportswear company contributing to the textile and apparel focus of the research. The case company is facing a potential restructure of its warehousing network as the current distribution strategy has created different constraints and complexities which have lead to problems. Through a literature review important supply chain drivers as well as warehousing variables have been identified and serve as the basis for the case company investigation conducted using interviews and a survey. The empirical findings contribute to the results by determining whether decisions regarding the variables are on a strategic, tactical or operational level. The result is a Decision Support System integrating supply chain drivers, warehousing variables and decision levels. The framework fills gaps found in the literature by defining different decision levels of warehousing and by integrating warehousing in the supply chain strategy. The Decision Support System is subsequently applied to the case company revealing areas which need to be considered and improved prior to a restructuring of its warehousing network. By using the Decision Support System a textile and apparel company can map its supply chain and warehousing strategy revealing strengths and weaknesses in the network. The Decision Support System facilitates decisions regarding warehousing and simplifies the process of moving from the strategy employed to the best practice strategy thereby increasing customer satisfaction and achieving a competitive advantage.

Keywords: Decision Support System, distribution and warehousing network, warehousing decisions, strategy, supply chain management, textile and apparel industry
Acknowledgement

We would like to express a special gratitude to the following people which have contributed to the completion of this master thesis:

Our supervisor at the Swedish School of Textiles, Rudrajeet Pal, for all the help, feedback and support we have received.

Our supervisor at the case company for giving us the opportunity to perform this master thesis and for the enthusiasm, help and support we have received.

The interviewees for devoting their time to participate in the study and for being open and honest making the research process positive and rewarding.

All the people at the case company for being positive and helpful and making us feel welcome.

Everyone else for the support.

Thank you!

Cecilia Colliander and Anna Tjellander
Borås, 2013
# Table of Contents

1. Introduction................................................................................................. 1  
   1.1 Background ......................................................................................... 1  
   1.2 Purpose ............................................................................................... 2  
   1.3 Objectives .......................................................................................... 3  
   1.4 Scope ................................................................................................. 3  
   1.5 Thesis structure .................................................................................. 3  

2. Literature Review ....................................................................................... 5  
   2.1 Warehousing strategy today ............................................................... 5  
   2.2 Description of the textile and apparel industry .................................... 6  
   2.3 The supply chain as a strategic function ........................................... 8  
   2.4 Levels and types of decision making ............................................... 9  
   2.5 Demand strategies ........................................................................... 11  
   2.6 The importance of warehousing in the distribution network ........... 12  
   2.7 Macroeconomic factors ................................................................... 16  
   2.8 Distribution ....................................................................................... 16  
   2.9 Centralisation versus decentralisation .......................................... 18  
   2.10 Information ...................................................................................... 22  
   2.11 Product strategies in the supply chain ........................................... 23  
   2.12 Service / Quality ........................................................................... 26  
   2.13 Time ............................................................................................... 27  
   2.14 Cost ............................................................................................... 28  

3. Problem Discussion .................................................................................. 32  

4. Methodology ............................................................................................ 35  
   4.1 Research strategy and research design ........................................... 35  
   4.2 Data collection ................................................................................ 36  
      4.2.1 Literature review ....................................................................... 36  
      4.2.2 Interviews ............................................................................... 37  
      4.2.3 Survey ................................................................................... 37  
      4.2.4 Site visits and organisational documents ............................... 38  
   4.3 Data analysis ................................................................................... 39  
      4.3.1 Frequency table ..................................................................... 39
7.2 Recommendations for the case company........................................77

8. Future Research..................................................................................79

List of References

Appendix A - Interview Guide
Appendix B - Survey
Appendix C - Explanation of the Variables
List of Figures

Figure 2.6.1  Warehousing (distribution centre operations) presented in the logistics management structure.
Figure 2.6.2  Firm characteristics affects the ownership decision of whether to keep the warehousing function in-house or to outsource it through 3PL.
Figure 2.9.1  The variables delivery time and inventory turnover are used for deciding whether to centralise or decentralise warehouses.
Figure 2.9.2  Product service levels should be managed differently depending on profit contribution of products and product demand by SKU.
Figure 2.11.1  Comparison of supply chain characteristics. Supply chain types are matched with a supply chain strategy depending on product, manufacturing and logistics characteristics.
Figure 2.14.1  A breakdown of costs related to warehousing.
Figure 2.14.2  Total logistics cost and its cost components and how these change with number of distribution centres in use.
Figure 2.14.3  A distribution network changes in configuration by a reduction of distribution centres and total logistics cost is affected.

List of Tables

Table 4.2.1  Frequency table presenting the eight supply chain drivers and corresponding distribution and warehousing variables.
Table 5.4.1  Survey data of supply chain drivers summarised and ranked according to perceived relative importance considering making supply chain design decisions.
Table 5.4.2  Survey data of variables summarised and ranked according to perceived relative importance considering making distribution and warehousing decisions.
Table 6.2.1  Strategic support framework.
Table 7.2.1  Summary of the strategic and tactical issues, the effects and corresponding recommended solutions for the case company.
### List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>3PL</td>
<td>Third Party Logistics Provider</td>
</tr>
<tr>
<td>4PL</td>
<td>Fourth Party Logistics Provider</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>FOB</td>
<td>Free On Board</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>SEK</td>
<td>Swedish Krona</td>
</tr>
<tr>
<td>SKU</td>
<td>Stock Keeping Unit</td>
</tr>
</tbody>
</table>
1. Introduction

This thesis examines which warehousing decisions that are considered strategically important. This chapter will provide a background to the subject and present the thesis purpose, objective and scope. To guide the reader an overall report structure is also provided.

1.1 Background

The most significant paradigm shift in modern business management is the change in focus from individual businesses competing as autonomous entities to competition through supply chains (Lambert and Cooper, 2000). The shift happened in the 1980s with an increase of companies competing on the global market (Yavuz, 2012). The quest to reach large number of customers on new markets led to the utilisation of low cost labour sources around the world. For the textile and apparel industry sourcing globally started in order to keep production costs down as the profit margins in the industry generally are low. Low cost labour sourcing has also been a way to meet and keep up with the development of fast moving complex customer needs in the industry (Bruce et al., 2004).

Today the ultimate success of a company is its ability to integrate supply chain activities and partners in its network. According to Lambert and Cooper (2000) management of relationships across the supply chain is called supply chain management. Ericsson (2011) state that supply chain management is one of the newer concepts dealing with the evolving complexity within businesses and with logistics as the backbone of supply chain thinking. Since the concept of supply chain management emerged in the 1980s it has transformed how markets are best served and how a significant competitive advantage can be gained but also lost if not well managed (Christopher and Holweg, 2011). Rouwenhorst et al. (2000) emphasises how distribution decisions influence all stages of the supply chain from production to end customer making logistics one of the most important functions within a company.

The design of a distribution network will affect the structure of the supply chain for several years. Distribution network decisions must also support the strategic objectives of the company in order to ensure the highest possible supply chain profitability (Chopra and Meindl, 2013). Changes in the warehouse network are often made for long term which makes it vital to understand and acknowledge a variety of different activities in the planning phase in order to prepare for uncertainties in the future. All network design decisions affect each other and
must also be revisited and reconsidered as a firm grows or as the market conditions change (ibid).

According to Daly (1993) many firms fail to recognise the importance of incorporating warehousing in the company strategy. The physical part of customer service can be found in warehouses as this is the last outpost from where goods are distributed, an aspect vital for customer satisfaction. Inadequate warehouse network design can therefore hinder companies from successfully serving the customer (ibid.). Yavuz (2012) states that warehousing has transformed from being a cost centre and a back office operation adding little value to become a critical component in the global supply chain with major impact on operations. The added complexity of increased product profilation, globalisation and consolidation among retailers and manufacturers put pressure on warehouses to be both responsive and cost effective (Maltz and DeHoratius, 2005). This is also discussed by Christopher et al. (2004) who states that the growing tendency to outsource functions lead to substantially longer lead-times which in turn creates longer pipelines with more inventory, increasing the pressure on the distribution network.

There are a wide range of names given to warehouses depending on its different roles (Rushton et al., 2010). However, with an increase of activities performed in warehouses the distinction between a warehouse and a distribution centre has become harder to make and is therefore left undefined by many authors (Higginson and Bookbinder, 2005). In this thesis it has therefore been necessary to determine and adopt a definition which will be used continuously throughout the paper. Warehouse will be used as a general term, however when needed the term distribution centre is used to explain the specific characteristics of a facility located closest to the end customer.

This study will look at the different elements of supply chain management that play a part when evaluating or considering making changes in the distribution and warehousing network. Recognising how these elements impact the warehousing network can lead to clearer and better decision making.

1.2 Purpose

The purpose of this thesis is to identify and investigate which supply chain drivers and specific variables that affect warehousing decisions and how these are strategically important. This will be done through a literature study and investigation of a case company operating in the textile and apparel industry with a focus on sportswear.
1.3 Objectives

The objective is to identify supply chain drivers and variables which affect warehousing decisions. The findings will serve as a decision support in warehouse network design. A table summarising the most frequent areas of supply chain management literature will provide a general overview of the most important supply chain drivers and warehousing variables for decision making. In order to categorise warehousing variables into decision levels a case company within the textile and apparel industry will be studied. The results obtained make the objective of the thesis focus on decision making regarding strategic warehousing in the textile and apparel industry.

1.4 Scope

The thesis is limited to decisions of warehousing where concepts of strategy and decision making are discussed from a supply chain perspective. Focus is put on identifying important supply chain drivers and variables associated with warehousing strategy and evaluation through common performance measurements within the field is not to be conducted. Layout and individual distribution centre operations such as receiving, put away, storage, order picking and shipping, will not be explained thoroughly since the scope of the thesis is warehouse network strategy. Finally, the case company studied operates in the textile and apparel industry worldwide, however, the scope is limited to its presence in the European region.

1.5 Thesis structure

The thesis structure is provided in order to guide the reader in the report disposition. In chapter 1 Introduction a background to the subject of warehousing as well as supply chain strategies is provided and the purpose of the study is presented. Chapter 2 Literature Review presents the most recent research within the field and narrows down to describing important supply chain drivers affecting warehousing decisions. Chapter 3 Problem Discussion frames the problem covered in the thesis by highlighting gaps in the existing literature. Based on these gaps the research question is developed and presented. A description of how this thesis has been conducted is presented in chapter 4 Methodology.

In order to gain insight to supply chain characteristics in the textile and apparel industry and at which levels decisions of warehousing are formed interviews were held and a survey conducted at a case company operating in the specific business. The outcome is presented in chapter 5 Empirical Study. In chapter 6 Analysis the
results from the literature review and empirical study are compared and synthesised forming the basis for development of the Decisions Support System. The support system is applied to the case company resulting in recommendations for solving the complexities in its warehousing structure. Chapter 7 Conclusion answers the research question of this study with help of the Decision Support System and the benefits with the system is summarised. Further the recommendations for the case company are presented as strategic and tactical level solutions. Finally, chapter 8 Future Research mentions possible ways to build on the developed Decision Support System.
2. Literature Review

The literature review contains research covering supply chain strategy as well as distribution and warehousing theories. It gives an in depth study of important supply chain drivers affecting warehousing decisions. The chapter summarises the relevant research for performing this study.

2.1 Warehousing strategy today

According to Ericsson (2011) the first logistics concept emerging in the 1960s was called *Cost Oriented Logistics* with the focus on reducing total costs in the materials flow. In the 1970s a new generation concept was introduced called *Revenue Oriented Logistics* which aimed to increase revenue by using logistics as a means of competition (ibid). Prior to the 1980s the typical firm executed its logistics activities purely on a functional basis and was primarily focused on the flow of goods and services with emphasis on distribution and storage (Frankel et al., 2008). The traditional objective for a warehouse was to facilitate the movement of goods through the supply chain to the end customer (Rushton et al., 2010). In the 1980s the two previous concepts were combined into *Profitability Oriented Logistics* with focus on reducing costs, increase profitability and decreasing capital tied up in inventory (Ericsson, 2011). As the logistics concepts broadened in the 1980s Supply Chain Management was introduced. Supply chain management was described as logistics outside the firm to include customers and suppliers. Logistics had been viewed as a functional silo within a company but the introduction of supply chain management marked a bigger concept with the management of material and information flows across the supply chain (Lambert and Cooper, 2000).

1980 also marked a milestone in the area of strategic management as Michael Porter published his book *Competitive Strategy* where it is argued that certain strategies as positions in the market place are desirable and the firms that occupy these positions enjoy higher profits than others in the industry (Mintzberg et al., 2009). Porter’s generic strategies and the analysis techniques used to identify these have proven to be insufficient and too static for the changing and dynamic markets of today (Porter, 1996). Based on the interaction between the changing environment and the advancement of technology logistics is continuously evolving. What started out as the coordination between operational activities such as transportation, materials handling and warehousing and has since evolved to coordination on a more strategic level including purchasing, manufacturing and physical distribution (Ericsson, 2011). Strategic schools today focus on strategy as
a transforming process changing as the state of the company changes, letting strategies emerge through resources and learning (Mintzberg et al., 2009).

Since development in the 1980s there has been a trend of reducing stock-keeping locations in companies’ warehousing strategies (Tompkins, 1991) (Higginson and Bookbinder, 2005). Daly (1993) describes this trend in warehousing as larger centralised warehouses that reduces inventory and improves customer service. The trend is enabled by the continuous improvement and enhancement of communication (Higginson and Bookbinder, 2005; Frankel et al., 2008). The focus on capital tied up in inventory continues with Gallman and Belvedere (2011) discussing how companies need to understand how to enhance logistic service without increasing inventory levels and holding costs. According to Pfahl et al. (1992) one approach to lower logistics cost is a centralised distribution structure. Schipper (2000), however, argues that after the trend of centralising warehouses in the 1980s and 1990s there has been a resurgence of decentralised warehouse operations.

During the 1990s market changes accelerated due to shortened product life cycles, growing requests for customisation, responsiveness of demand and furthermore reliance on information technology. Tompkins (1991) claims that the 1990s brought a new era where appreciation of the value-adding aspects of having product availability resulted in adapting warehouses to the new requirements. Decisions regarding the role of warehouses in the supply chain affect the company’s competitive landscape. In the 2000s the main focus has been on collaboration and co-ordination of non-material activities (Frankel et al., 2008). In recent years there has been an increase in demand for warehouses and distribution space due to the added services carried out later in the value chain which were traditionally performed in factories, for example, packaging, labelling and light assembly (ibid). Tompkins (1991) states that in the future warehouses will become increasingly automated, fast paced, integrated and flexible. Schipper (2000) argues that the determination of the right warehouse structure is based on each company’s needs and the best way to provide time- and value-added services. In the warehouse and distribution centre in the future there will be greater emphasis on reducing activity time (Higginson and Bookbinder, 2005).

2.2 Description of the textile and apparel industry

The trend in the textile and apparel industry has been to outsource production to low labour cost areas (Christopher et al., 2004). Although there is a substantial cost advantage of using off-shore production it has resulted in longer lead times. The result is inventory tied up and moving through longer intercontinental pipe
lines. The outsourcing decision has presented complexity to textile and apparel companies’ supply chains as it contradicts the unpredictable characteristics of the industry demanding more responsive systems (ibid). In addition textile and apparel markets are described as synonymous with rapid change characterised by short life cycles, high volatility and low predictability (Bruce et al., 2004). The textile and apparel industry is also one of the most challenging industries for logistics management due to the number of styles, sizes and colours on the retail shelf at any given time (Christopher et al., 2004). In addition, the average time a product can be found at a retailer is decreasing as product life cycles are becoming shorter and profit margins lower. Consequently companies are trying to produce products more rapidly in order to avoid keeping stock while still managing product availability (Bruce et al., 2004). As the textile and apparel industry has become increasingly competitive the success of many companies has become more determined by the ability to be flexible and responsive in order to meet demand. As a result traditional organisational structures and forecast driven supply chains can be inadequate (Christopher et al., 2004).

For a long time the sport goods market was rapidly growing, however in the end of the 1990s and beginning of 2000s the growth slowed down forcing many companies out of business consequently strengthening the market entry barriers. The changes in the market cemented it as an oligopoly making a few larger actors even more dominant. The sports goods market has been characterised by a few large transnational players with a number of smaller local companies on each market (Andreff and Szymanski, 2006). Today the sport goods market is growing again on both established markets such as Western Europe as well as newer markets such as China (Ko et al., 2012). The demand for sports goods is described as highly segmented depending on sport and the size of the segment is largely determined by the number of participants. Some products can however have a less narrow segment and can be worn during leisure time as well as sporting activities (Andreff and Szymanski, 2006). This is supported by Ko et al. (2012) which state that sportswear is used increasingly in everyday situations. The results of a study by the authors show that the largest segments within sportswear are fashion seekers willing to pay a high price for the latest trends in sportswear, the conspicuous fashion consumers who rely on brand reputation and trendiness, sensational seekers who value functionality as well as technology and sociable followers who care about the activity but are less concerned with the fashion aspect and adventure. Consequently the market for sportswear is increasingly taking on characteristics of the textile and apparel industry (ibid).
2.3 The supply chain as a strategic function

According to Hoffman (2010) The Council of Supply Chain Management portray supply chain management as a strategic level concept. The supply chain has become increasingly strategic, rather than transactional, and therefore needs an integrated and holistic perspective of how products and processes should be aligned with the strategic decisions of the company (Stavrulaki and Davis, 2010). However Nollet et al. (2005) believe it is important to understand that not all supply activities are strategic in nature. For example logistics as explained by Stank et al. (2005) cannot be considered strategic however it is a core competence that contributes to strategy. The authors however emphasises that supply chain management is a much greater activity than only an extension of logistics and supply chain managers should be positioned together with upper level management (ibid).

Porter (1996) explains competitive strategy as “being different” by choosing activities different from other firms and deliver a unique value mix. As the environment changes firms will need to rethink the strategy and realign according to it (Sehgal, 2011). Change is constant but the pace of change is different for specific industries however a strategy will enable a firm to continue moving forward through change. A company’s competitive strategy has large impact on the design decisions within the supply chain network. At the extremes, a focus on cost efficiency would probably seek the lowest cost location whereas a focus on responsiveness would lead to location of facilities closer to the markets independent on cost (Chopra and Meindl, 2013). In reality a supply chain is more complex and it must be “…agile but also lean, it should be demand driven but also supply aware, it should help lower cost but also raise efficiency.” (Sehgal, 2011 p. xxii)

To create a successful firm a company’s supply chain strategy and competitive strategy must be aligned in a so called strategic fit. If there is a mismatch between supply chain design and customer needs restructuring of the supply chain must be implemented or alternatively changes to the competitive strategy must be made (Chopra and Meindl, 2013). Porter (1996) discusses strategic fit in similar terms and states that not only is it fundamental for the competitive advantage but also for sustaining said advantage as it is significantly harder for competitors to match an integration of functions and activities rather than to imitate a sole function in the supply chain. Mintzberg et al. (2009) explain that it is with systems of production a company competes in the marketplace and not with its products. In order to achieve sustainable advantage Porter (1996) states that positioning the company is not enough since it is closely connected to trade-offs. Trade-offs
occurs when positioning a company by choosing a certain image or reputation, different product configurations and also from limits in coordination and control. Trade-offs are important for competition and as well essential for strategy. In supply chain management there is a well known trade-off between the desired levels of service and cost highlighted by Baker (2007), Gallman and Belverde (2011) and Napolitano (1997). Coyle et al. (2009) mention cost as efficiency and service or value as effectiveness in the supply chain.

2.4 Levels and types of decision making

Nollet et al. (2005) argue that there are three accepted levels of strategy making which are corporate, business and functional. The corporate and business strategies are more holistic and long-term, intended to provide the whole company with continuity and integrity. According to Stank et al. (2005) corporate strategy includes drawing the lines within which the firm competes, development of product groups, financial objectives and strategies relative to growth. Further Hoffman (2010) means that supply chain strategy at the corporate level may seek synergy effects and value by coordination of corporate activities. The level of diversification of product portfolios in the different business areas will determine the number of different supply chains to use. The more alike business areas will lead to firms trying to benefit from economies of scale through more centralised control (ibid).

The business unit strategy is dealing with how a company competes. Functional strategies concern operational activities for example purchasing, production, logistics, distribution and IT. It is important that the functional activities are strategically aligned with each other (Hoffman, 2010). The functional level creates capabilities that can be used as a contribution to core competence (Stank et al., 2005). Hoffman (2010) argue that it is not one strategy level that in isolation affects performance but rather a match and interaction between more general firm strategies and more specific supply chain strategies. Logistic activities are highly integrated with other operational functions (Rodrigues et al., 2004) and therefore, as Nollet et al. (2005) explain, a supply strategy should be following both the corporate strategy as well as business strategy but also be consolidated with functional strategies.

To the three previous mentioned strategy levels Hoffman (2010) adds one strategy level called the network level. The author means that strategy, except previous mentioned levels, also must cover interaction with other companies. This is in line with Monczka and Morgan (2003) explaining that strategic relationships with suppliers and customers is a factor closely linked to the success of supply chain
management programs and strategies. The importance of integrated operations and relationship strategies in order to achieve improvement in logistic performance is also stressed by Rodrigues et al. (2004) and Gallman and Belverde (2011). However, a high level of integration in the supply chain is easiest to achieve when having a low number of partners (Gallman and Belvedere, 2011).

Integrated operations and relationships are necessary prerequisites to develop measurement and information systems that support the relational processes (Rodriguez et al., 2004). Gunasekaran et al. (2004) suggest developing a performance measurement programme in the supply chain to achieve complete supply chain integration. All partners would then take part in cross-functional processes that are both well planned and well coordinated. A key to working relationships is having all parties agree on targets and together work to reach these (Hardman et al., 2007). Further relationships rely on knowledge of each others’ operations and mutual improvement toward flexibility and transparency. In Gallman and Belvedere’s (2011) study the companies pursuing the highest level of collaborative practices, which included frequent update and control of stock, also showed the strongest level of attention and excellence in inventory management.

Management is involved in making strategic, tactical and operational decisions as explained by Schmidt and Wilhelm (2000) and each level is limited to decisions made at higher levels. Further the time frame often referred to concerning decision levels is not what primarily distinguishes the different levels instead it is the type of decision entailed. The design of the logistics network is set at the strategic level and the environment created by the design is a basis from where tactical and operational level decisions will need to perform (ibid). Elements of a supply chain strategy should correspond to goals at the higher strategy levels (Nollet et al., 2005). Since a supply strategy is important for the coherence of other functional strategies the process is two-way and should go both from general to functional and from functional to general. This process is not always followed and two reasons are pointed out by Nollet et al. (2005) first the way manufacturing and operations supply become embedded in supply management and second due to often weak communication between functions. Rodrigues et al. (2004) also explain that operational activities and strategy should be aligned and supported with a suitable measurement and information system.

According to Nollet et al. (2005) a supply chain strategy should start with segmentation and focus on the company’s characteristics, its management style and culture. Wanke and Zinn (2004) mean further that strategic choices are made to deal with uncertainty, costs and customer service. The authors’ study deals with
three strategic level decisions logistics managers need to be involved in, (1) make to stock versus make to order, (2) push versus pull inventory and (3) centralisation versus decentralisation of inventory. The results from the study suggest that product, demand and operational data are useful when making strategic decisions within logistics. Schmidt and Wilhelm (2000) mean that tactical decisions include material flows through the whole supply chain and that decisions regarding decentralisation and centralisation are formed at this level. Gunasekaran et al. (2004) support this by explaining that allocation of resources is a tactical level decision. The authors continues to list performance measures related to the tactical level including; booking procedures, assurance of quality levels, cash flow and capacity flexibility. Schmidt and Wilhelm (2000) mean further that at the tactical decision level it is important to measure customer service and provide the information to the strategic level and from there evaluate the network design.

Operational measures represent day-to-day activities and adherence to the developed schedules as explained by Gunasekaran et al. (2004). The goal with operational activities is to achieve defect free deliveries to customers. Schmidt and Wilhelm (2000) add that the operational level is important as it directly affects customer service and therefore can be considered essential in order to provide unified logistics processes.

2.5 Demand strategies

Understanding what the customer wants is fundamental for being a successful company (Schmidt and Wilhelm, 2000) and customer service is closely linked to the process of distribution and logistics (Rushton et al., 2010). A logistics network should be designed according to the marketplace where it competes, however specific industries accommodate different needs as emphasised by Schmidt and Wilhelm (2000). The first thing a company should do in order to establish a total view of the supply chain is to focus on the consumer (Monczka and Morgan, 2003). Nollet et al. (2005) point out that traditionally supply management has not been considered customer oriented. However, since “pull” strategies and value approach have received more attention both service and customisation are suggested as key drivers for strategy making within supply management (ibid). There are many elements of the distribution network that affect the customer’s perceived service level such as delivery reliability and stock availability (Rushton et al., 2010). All functions within a business must focus on meeting customers’ requirements in order to exceed their expectations as explained by Ericsson (2011).
Customer need is the driver which serves as the basis for why the customer procures a good or service (Rushton et al., 2010). To keep a competitive advantage supply management must make efforts to direct value for each customer through the supply chain (Nollet et al., 2005). According to Chopra and Meindl (2013) it is vital for companies to understand what is demanded in the market and subsequently define the desired service and cost requirements. This makes a company better prepared for changes and disruptions in the supply chain. It can, however, be difficult to distinguish what customer service really is but Rushton et al. (2010) suggest that it can be done by differentiating the core product from the service elements related to the product. Christopher and Towill (2001) describe a similar reasoning when discussing market winners and market qualifiers. Depending on if the winning criterion is cost or service they suggest employing either a lean or an agile supply chain. The order winning criteria as explained by Christopher (2005) are those elements of the offer which have a clearly identifiable impact on the customer’s own value-adding process. It is the totality of the offer which delivers value to the customer. Whatever the driver, Lee (2002) means that the supply chain strategy must be tailored to meet the specific customer need.

2.6 The importance of warehousing in the distribution network

Well performed distribution design and operation can lead to profitability and success for an entire business (Baker, 2008). The competitive strategy of a firm has impact on the supply chain network design ranging from a focus on high responsiveness to low cost. Therefore companies operating in the same industry might select distribution networks different from each other. However in each case the overall goal with supply chain network design is to maximise supply chain profitability (Chopra and Meindl, 2013). The activities performed by the supply chain need support by nodes in the network for example assembly, order consolidation and coordination. The characteristics of these nodes differ but often they require elements of storage or distribution (Higginson and Bookbinder, 2005).

Rushton et al. (2010) mean that the logistics network plan must be closely linked to the corporate plan and competitive plan of the company. Traditionally logistics have been dependent on the warehouse location and number of facilities however other important factors need to be recognised for example the design of processes, information systems and organisational structure. The designing of a distribution network can be divided into two phases (Chopra and Meindl, 2013) and since distribution centres are part of a warehouse network that serves the customers (Baker, 2008) the design starts with visualising of the supply chain network. The
visualising part as explained by Chopra and Meindl (2013) includes decisions regarding how the product offered will be sold. The second phase is more specific and includes allocation of demand, capability and capacity planning as well as decision of specific locations.

Frazelle (2002) means that warehouse management and operations is integrated and dependent upon all other logistics activities see figure 2.6.1. There are five main logistic activities and warehousing is considered a service to the other four areas. Planning in the other logistic areas may therefore decrease or eliminate the need for a warehouse since a warehouse must be designed to meet requirements set by the other logistic activities (ibid).

Controlling of processes is important for improving the performance of a supply chain and such controlling can to a large part be achieved by different measurements (Gunasekaran et al., 2004). For effective supply chain management performance measurement goals must reflect the overall supply chain goals and build on insights for the desired directions of improvements (Gunasekaran et al., 2001). Higginson and Bookbinder (2005) highlight throughput and inventory turns as common measures for evaluation of distribution centres. De Koster and Balk (2008) suggest looking at operation efficiency as the sum of output compared to the sum of input. Gunasekaran et al. (2001) mean that performance measures are best used the fewer they are. Chopra and Meindl (2013) point out six important drivers called facility, inventory, transportation, information, sourcing and pricing which all work in interaction and determine supply chain performance. In order to achieve balance in the supply chain these six drivers will need to be considered and managed in a way that meet customers’ desired level of responsiveness at lowest cost.
Factors influencing the need for replanning of the logistics network are according to Ballou (1995) changes in distribution and sales, the competitive environment, customer service levels, product characteristics, logistics cost and financial issues. Rushton et al. (2010) have also recognised major driving forces of logistics change and ranked these, according to its influencing factor, in the order; cost, service, speed, integration of information technology and globalisation. Frazelle (2002) further explains that it is important to start profiling and benchmarking current warehouse practices before changing distribution design or warehousing layout. At the conceptualising stage there exist large opportunities for improvement and cost related to changes is at its lowest. As the project moves on from the conceptualising phase; design, implementing and maintenance, opportunities for improvements will decrease and cost will exponentially increase. According to Baker (2008) variances remaining after the implementing process must be handled at the individual warehouse or distribution network level. The warehouse functions serves as a buffer between incoming and outgoing flows (Pfohl et al., 1992) and keeps inventory to smooth variations between supply and demand (Rushton et al., 2010).

Distribution network design addresses strategic issues of where to place warehouses and decisions of which type of warehouse that will serve specific retailers. A common approach in solving this problem is to examine the effects of network structure in relation to costs components like inventory, location and transportation. The complexity of the problem is often solved with mixed inter linear programming and optimisation models (Chung-Piaw and Jia, 2004). The objective is often to find the least costly distribution system that make all customer demand satisfied while including constraints such as number of plants and each warehouse capacity (Amiri, 2006). The aim with a distribution network design is typically to find the best strategy from plant to warehouse and next from warehouse to consumer (ibid). Baker (2008) describes that the process of designing a warehouse network involves decisions regarding the number, location and size of facilities and also if these should be leased, outsourced or owned. Coyle et al. (2009) explain that ownership of a warehouse concerns whether the warehouse should be owned by the user or outsourced to a third-party logistics provider (3PL). A firm can also outsource to a fourth-party logistics (4PL). A 4PL acts as a general contractor who manages the functions targeted by 3PLs such as warehouse and transportation (Chopra and Meindl, 2013).

Coyle et al. (2009) have indentified firm characteristics which can affect the ownership decision of warehousing, see figure 2.6.2. The authors explain that managing the warehousing function in-house is more suitable for companies producing a high and constant volume of products with predictable demand. If
physical control is needed and security requirements are high engaging a third-party would result in loss of control, however, if a company is small the expertise of a third-party can increase control (Chopra and Meindl, 2013). Rushton and Walker (2007) explain that logistics can be used as a competitive advantage for a company and therefore the use of 3PL might create difficulties in controlling and managing the logistic function. However, by managing the relationship with the 3PL it is possible to maintain some insight and control. Chopra and Meindl (2013) state that not all companies have the same possibility to achieve cost effectiveness to the extent of 3PL companies and therefore outsourcing the warehousing function can be a strategically right decision. However, Rushton and Walker (2007) emphasise that cost reduction benefits by using 3PL should not out weight the customer service. A 3PL can increase the value in the supply chain if performing an activity more cost effective than if it was kept in-house (ibid). If a firm has special service requirements that other companies using the same 3PL warehouse do not need, outsourcing to a third party is not likely to add value for that specific firm (Coyle et al., 2009). The reason outsourcing would not add value in such a case is because a 3PL cannot accommodate all special requirements. Managing the warehousing function in-house is expensive. When outsourcing the warehouse function costs are mostly variable whereas keeping the warehouse function in-house represents a higher degree of fixed costs. If flexibility of storage is desired then third-party is preferable (ibid). Chopra and Meindl (2013) mention different alternatives when managing an outsourced warehousing function, such as long term leasing of warehouse space or get the space required on the spot market. Tompkins (1991) and Rushton and Walker (2007) suggests using public or outsourced warehouses to handle inventory peaks during the year.

<table>
<thead>
<tr>
<th>Firm characteristics</th>
<th>In-house</th>
<th>3PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput volume</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Demand variability</td>
<td>Stable</td>
<td>Fluctuating</td>
</tr>
<tr>
<td>Market density</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Special physical control</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Customer service required</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Multiple use needed</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Figure 2.6.2. Firm characteristics affect the ownership decision of whether to keep the warehousing function in-house or to outsource it through 3PL (Coyle et al., 2009).
2.7 Macroeconomic factors

The need to satisfy demand as well as shareholders has led to companies focusing on manufacturing and distribution efficiencies, attempting to reduce costs. Low cost countries have offered such opportunities but also present demanding challenges for the logistics requirements (Rushton and Walker, 2007). Designing a global logistics network must deal with economic factors like market prices, interest rates, cost of production and transportation. Some values are more specific and dependent on country, so called macroeconomics, and a logistics network must be designed and operated in a way that exploits this (Schmidt and Wilhelm, 2000). Macroeconomic factors and its influence over the success of supply chains are also highlighted by Chopra and Meindl (2013) including tariffs and tax incentives, exchange rates and demand risks, political factors, infrastructure factors and competitive factors. These factors are needed to take into account when making network design decisions. Choosing specific regions includes analysis of logistic costs, regional demand as well as competitive environment and risks whereas decisions of number of sites includes defining a level of infrastructure and response times (ibid). De Marco et al. (2010) mean that when considering low cost and logistics performance, the geographical location and size of the warehouse are more important compared to building details and design decisions. Placing a distribution centre in an emerging market such as Eastern Europe will probably not lead to any time constraints or add any similar complexities to the supply chain. However, from a logistics perspective the limited infrastructure would make especially in-house operations a high risk (ibid). Decisions regarding choice of specific regions and number of sites to use should be considered after the supply chain strategy is set (Chopra and Meindl, 2013).

2.8 Distribution

When designing its distribution network a company must decide on how it wants the product to reach the end customer as this will have significance to further decisions in the supply chain (Chopra and Meindl, 2013). Two key decisions to be taken into consideration are listed. First, if the product should be delivered to the customer’s location or picked up from a set place. Second, if the product should move through an intermediary location. Such decisions are important to consider since a distribution centre can play many different roles in the supply chain (Higginson and Bookbinder, 2005). Determining the role of facilities is also important since it determines the amount of flexibility in the supply chain with changes in demand (Amiri, 2006).
Traditional warehousing activities involve processes of receiving goods and inspection, put away and storage as well as order picking or assembly and shipping of goods (Frazelle, 2002).

Transhipment centre is used when there is a need to change vehicle type or transportation mode (Higginson and Bookbinder, 2005).

Cross-docking centre is used when customer orders are filled from other sources for example a manufacturing plant and only pass through the distribution centre. Rushton et al. (2010) explain that products in a cross-docking centre are not stored for long but are more or less directly transferred to customers. In a cross-docking centre products that are being shipped in the same direction can be consolidated for outbound delivery (Higginson and Bookbinder, 2005).

A firm must decide whether the distribution centres will be primarily cross-docking centres or facilities for storage. For a facility used primarily for storage a firm must also decide which products that should be stored at each facility (Chopra and Meindl, 2013). Rushton et al. (2010) explains that it is beneficial if a facility holding inventory also is performing some type of value adding activity for example,

- Freight consolidation centre where customer orders or product lines can be dispatched together in one delivery (Rushton et al., 2010) in order to receive transport economies of scale (Higginson and Bookbinder, 2005).
- Assembly centre where final configuration activities can take place (Higginson and Bookbinder, 2005) such as labelling (Rushton et al., 2010).
- Some warehouses are also used as a returned goods centre, which have increased considerably since the growing use of Internet shopping (Rushton et al., 2010).

Christopher and Towill (2001) mean that inventory should be held in a generic form and final completion of products should be made when exact customer requirement is known. An important element in such postponement strategies is to find out which product variables that consumers value the most and which ones of these that can be applied or changed later in the process (Hardman et al., 2007). Mason-Jones and Towill (1999) explain that postponement strategies requires a careful analysis of the place where the goods will be held as it can be seen as strategic stock acting as a buffer in the supply chain. According to Baker (2004) most distribution centres perform some type of value adding activities usually by labelling, tagging and pricing but relatively small warehouse area is given to such activities. Instead distribution centres usually hold strategic inventory to be able to manage volatility at the local markets. Baker (2004) means that is due to
companies being driven by inventory based thinking rather than concepts based on information.

There are indications of increased use of large distribution centres in supply chains today (Baker, 2004). A distribution network with fewer but larger warehouses can result in lower inventory in the supply chain with decreased potential loss of operation efficiency. However space has a negative correlation to efficiency (Hackman, 2008). According to Frazelle (2002), who has been studying warehouse size in relation to performance, there seems to be little support for economies of scale in distribution and warehousing operations. An improper sequencing of tasks or improper order batching will, due to the longer travel distances, result in an exponential growth of penalty time which in turn leads to increased warehousing costs. In large facilities Hackman (2008) explains how poor visibility of work flow, long distances of travel and difficulties of communication as well as supervision seem to offset improvements coming from increased order volumes and improvement in information systems and high levels of mechanisation. According to Frazelle (2002) as the warehouse size increases so does also the need for control. The greater need for control the more experienced the warehousing managers need to be.

2.9 Centralisation versus decentralisation

Decisions regarding the actual location of a facility and capacity allocation for each facility includes analysis of logistics cost such as facility, transportation and inventory cost. The trade-off concerns whether to centralise for economies of scale or decentralise in order to increase responsiveness by having facilities located closer to customers (Chopra and Meindl, 2013). Christopher (2005) states that there is a trend towards centralisation of inventory at fewer locations as a consequence of globalisation. National warehouses have been consolidated into regional distribution centres serving a greater geographical area. Chopra and Meindl (2013) explain that after a company merger consolidation of facilities, change of location as well as change of warehousing roles will usually improve responsiveness and reduce costs due to differences in the market as well as redundancies. Melachrinoudis and Min (2007) explain that a consolidation strategy means that regional warehouses are consolidated into fewer stocking points and underutilised or redundant warehouses are phased-out. The authors continue that such a strategy allows for better asset utilisation and a higher throughput. Centralisation of inventory is one strategy for minimising inventory

---

1 Hackman (2008) defines a small warehouse to be under 175 000 square feet and a large warehouses to be over 500 000 square feet.
levels and safety stock can be lowered with fewer distribution centres in use (Baker, 2007). Benefits with centralisation of inventory are well established. However Christopher (2005) recognises that having inventory located strategically near production or close to customers and managed centrally may be even more beneficial and provide greater flexibility. A decentralised inventory strategy with central coordination reduces handling costs, transport costs and supply lead times compared to a centralised distribution centre. In addition, stock reductions can be achieved to the same extent as the use of a central distribution centre. In order to achieve successful results with a central coordinated warehousing function an integrated information system is required in the organisation (Christopher, 2005).

Having the distribution centre as close to the customer as possible serves to ensure the shortest lead-times (Mason-Jones and Towill, 1999). Few location studies are made without computer based models according to Ballou (1995) and optimising facility location can save between 5 to 15 percent of logistics cost. Meshkat and Ballou (1996) explain that there will always be uncertainty involved in network optimisation one of which is product availability. If products are not available in the assigned warehouse secondary warehouses need to be used and transportation costs increases. Inventory cost should be closely linked to warehouse location decisions as inventory levels will change with number of facilities used and the demand allocated to each facility (Ballou, 2005). Capacity allocation can be changed more easily compared to location decisions however also capacity decisions will stay in place for a long time. If too much capacity is allocated to a warehouse it will result in poor utilisation and higher costs. Not enough capacity will decrease responsiveness and if the order is filled from another more distant facility costs will increase (Chopra and Meindl, 2013). The ratio between used floor area and freight volume must be appropriately sized in order to avoid either under or over utilisation of the facility (De Marco et al., 2010).

Warehouse location is usually considered an important problem linked to strategic planning and involves top management interest (Ballou, 1995). It has a long-term impact on the performance of a supply chain since it is expensive to close a facility or move it to another location (Chopra and Meindl, 2013). By having distribution centres facilitating responsiveness the distribution network will become more flexible which can be an advantage other companies will have trouble imitating as distribution centres form a long-term asset. Distribution centres may thereby be part of a company’s competitive strategy. To ensure being responsive distribution centres need to be integrated in the design and planning of logistics operations (Baker, 2008). Specific locations of facilities will have impact on the amount and form of communication developed in the supply chain.
network. A facility located far from the head-office will lead to a more autonomous facility whereas facilities located close to each other will encourage communication (Chopra and Meindl, 2013). The two variables delivery time and inventory turns per year can be used to decide whether decentralisation or centralisation of inventory is preferable, see figure 2.9.1.

![Graph showing Decentralization and Centralization](image)

Fig 2.9.1. The variables delivery time and inventory turnover are used for deciding whether to centralise or decentralise warehouses (Wanke and Zinn, 2004).

A company should centralise inventory rather than decentralise if the inventory turnover is below 16 turns a year according to the figure, and for centralisation the longer delivery time requires increased inventory turnover (Wanke and Zinn, 2004). Delivery time is the most important predictor when deciding on centralisation versus decentralisation and delivery time therefore dominates over inventory turns in the relationship. However a single variable is not enough as a basis for decision making since at least two variables impact logistics management (ibid).

Stock or stock availability is a characteristic of logistics service (Gallman and Belverde, 2011) and can therefore be considered a key service metric (Baker 2007). There are different ways to measure product availability and one is by measuring the order fill rate which is the amount of orders that are filled from available inventory. If a multiproduct order is placed the order is filled only if all products can be supplied from the available inventory (Chopra and Meindl, 2013). However, all customer orders cannot always be filled from one warehouse because inventory policies do not provide full product availability for all levels of demand. To keep 100 percent in safety stock would neither be cost effective nor practical (Meshkat and Ballou, 1996). Baker (2007) explains that some industries might even be suited for pushing products to the market by indentifying trends without any inventory holding at all, for example where product life cycles are shorter. Regardless of the debate over inventory levels and the effect on
performance, holding of inventory is still one key role for warehouses as explained by Baker (2007) and it is difficult to completely eliminate the need for inventory buffers. The question is rather how correct inventory levels should be determined.

In Gallman and Belverde’s (2011) study it is assumed that improved service level is achieved through inventory management and also warehouse management. The effectiveness of inventory management is depending on forecasting accuracy compared to actual demand. Warehousing management on the other hand becomes more important the higher number of stock keeping units (SKUs) to be handled (ibid). Christopher (2005) has developed ways to manage different product service levels, see figure 2.9.2, where different profit contribution of products is matched with product demand by SKU.

![Diagram of product service levels](image)

Fig 2.9.2. Product service levels should be managed differently depending on profit contribution of products and product demand by SKU (Christopher, 2005).

Based on the figure Christopher (2005) suggests that (4) low volume – high profit contribution products should be managed centrally. Storage of those products should be held as far back up in the supply chain as possible in order to reduce inventory investments. (3) Low volume – low profit contribution products should be reviewed regularly with the objective of deleting them from the product range unless these products are needed from a strategic point of view. (1) High volume – low profit contribution products need to be examined from a product and logistics cost point of view with the aim to enhance profits. Products with (2) high volume and high profit contribution should be held as close as possible to the customers with high availability. Christopher (2005) means that there are few such products, like the latter, and therefore such a costly strategy can be afforded.
2.10 Information

The evolvement of logistics management and subsequently supply chain management has always been driven by the new development in information technology (Ericsson, 2011). A good flow of information is essential for the maintenance of an efficient distribution service (Rushton and Walker, 2007). Demand forecasting form the starting point of all supply chain planning and should be based on decisions which include how much of a particular product to produce, how much inventory to hold and how many products to order. A company needs to identify which factors that influence demand and make demand increase or decrease including possible sales peaks throughout the year (Chopra and Meindl, 2013). According to Gallman and Belvedere (2011) the effectiveness of inventory management relies heavily on the forecasting process and demand management. Forecasts are rarely accurate but well defined customer segments and demand information can facilitate and simplify the forecasting and in effect lead to better stock availability (Chopra and Meindl, 2013).

Better stock availability can also be achieved through an information sharing initiative (Stavrulaki and Davis, 2010). It is not enough to optimise internal structures and infrastructure (Frohlich and Westbrook, 2001). Retailers and suppliers also need to be connected through shared information on real demand in order for all involved in the supply chain to be working towards the same goals (Christopher et al., 2004). In order to successfully implement information sharing initiatives focus must also be put on the warehouse design and how to optimise it (Hackman et al., 2001). Integrated information systems can reduce the reliance on forecasts and build a better and more accurate platform for planning (Frohlich and Westbrook, 2001).

Christopher (2005) explains how information systems can capture demand as close to real-time as possible and that a suitable logistics response can be made directly based on that information. As a result information substitutes inventory and the enhanced processing time also contributes to reduced lead times. In the study of Hackman et al. (2001) the usage of information technology resulted in warehouses doing considerably more work in less time. Ericsson (2011) is discussing a similar scenario when stating that a large number of people are often involved in creating, communicating and executing inaccurate forecasts which leads to constantly changing plans, turbulence and bull whip effects. Ericsson (2011) continues that such complexity in the supply chain can be reduced by using information technology to enhance the logistic flows. In the textile and apparel industry integrating the information in the supply chain is beneficial if
timely responses to internal and external changes are to be achieved (Christopher et al., 2004).

In large warehouses and distribution centres there can be a high amount of orders processed every day requiring sufficient information technology to handle the process complexity (Rushton et al., 2010). Chopra (2001) emphasises the importance of efficient order visibility through an information system which also is dependent on supply chain integration to be successful. Data and information is the foundation for a responsive supply chain and a timely and accurate flow of information require that performance relies on forming alliances and relationships, both internal as well as external (Christopher et al., 2004). According to Ericsson (2011) information sharing through collaboration in the supply chain can add perceived value and decrease inventory and create a competitive advantage that cannot be attributed to a specific entity but the entire channel. The more information available the simpler supply and demand decisions become, lowering the risk of stock outs and obsolete inventory (Frohlich and Westbrook, 2001). To achieve efficient information sharing it is necessary to have sufficient Information and Communication Technology (ICT) (Ericsson, 2011).

2.11 Product strategies in the supply chain

The growing importance of strategic supply chain management motivates managers to better learn and understand the links between products and activities in the supply chain (Stavrulaki and Davis, 2010). Strategic alignment of products and supply chain processes has been highlighted by several authors with the most influential probably being Fisher. Fisher (1997) states that the creation of the supply chain is determined by the characteristics of the product including product life cycle, product variety and demand predictability. Depending on these characteristics products are divided into either a functional or innovative category which each requires distinctly different supply chains. According to Lee (2002) functional products have stable demand and therefore longer product life cycles with less product variety. In addition, profit margins are low and cost of obsolete inventory is also low. Fisher (1997) explains that predictable demand leads to increased competition with lower margins as a result. However in order to avoid low margins innovations in technology are introduced as an additional reason for customers to make a purchase. Innovative products have therefore, as explained by Lee (2002), shorter life cycles and Christopher (2005) means that over the last decades product life cycles have become even shorter. Product variety for innovative products are larger compared to functional products since product variety depends on fast introduction of products or new technology advancements (Lee, 2002). The newness of innovative products leads to unpredictable demand
which also is enhanced by the greater variety of innovative products (Fisher, 1997). Innovative products usually have higher profit margins as well as higher cost for obsolescence (Lee, 2002). ABC categorisation is a tool for identification of product profitability. A-products represent high volume high profitability products and C-products lower volume less profitable products. The higher profitability by product the higher service should be offered and the higher profitability the higher level of stock availability should be kept (Christopher, 2005).

A challenge with increases in product variety and decreases in product life cycles is to maintain the strategic fit. It becomes even more challenging when new products are introduced without eliminating older ones (Chopra and Meindl, 2013). Alignment between products and corresponding supply chain must be reassessed over time as growth in production volumes, advancements in technology and expansion of the customer base make the supply chain move away from the strategic fit (Stavrulaki and Davis, 2010). The nature of demand and customer needs also changes during the product life cycle. In the introductory phase only a leading edge of customers are interested in the product leading to uncertain supply. When a product has become a commodity the market is saturated and the demand becomes more predictable. Chopra and Meindl (2013) therefore mean that supply chain strategy should evolve continuously as the product enters different phases in its life cycle.

It can be difficult to completely remove uncertainty from the supply chain because of the type of product involved, for example highly fashionable items likely face unpredictable demand. Irrespective of the situation the supply chain strategy must be developed in a way that enables a match between demand and supply (Christopher and Towill, 2001). According to Fisher (1997) the products offered are therefore a first step in creating an effective strategy for the supply chain.

Within the textile and apparel industry Hardman et al. (2007) acknowledges that different garments have different characteristics, for example the nature of the market is different for blue jeans than trendy tops, thus making garments similar to the distinction between functional and innovative products. Different supply chain strategies should be developed for these products and according to Hardman et al. (2007) it will give an ideal balance between complexity and flexibility in the supply chain. Fisher (1997) means that product type and supply process should be matched in a way that make functional products receive an efficient process and innovative products a responsive process. Most companies use a combination of delivery networks depending on product characteristics and strategic position (Chopra and Meindl, 2013). Stavrulaki and Davis (2010) identify four supply
chain types depending on product characteristics that are; build-to-stock, assemble-to-order, make-to-order and design-to-order. Each supply chain type is then matched with a supply chain strategy, see figure 2.11.1, comparison of supply chain characteristics.

<table>
<thead>
<tr>
<th>Comparison of supply chain characteristics</th>
<th>Build-to-Order</th>
<th>Assembly-to-Order</th>
<th>Make-to-Order</th>
<th>Design-to-Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit margin, Product variety, Order lead time, Demand</td>
<td>Low</td>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Product life cycle, Volume</td>
<td>High</td>
<td></td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Production Process</td>
<td>Continuous, Large volume assembly</td>
<td>Assembly line process</td>
<td>Small batches</td>
<td>Job shops projects</td>
</tr>
<tr>
<td>Product Design</td>
<td>Cost conscious</td>
<td>Modular</td>
<td>Specialized</td>
<td></td>
</tr>
<tr>
<td>Manufacturing contact with customer</td>
<td>Uncommon</td>
<td></td>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Focus of manufacturing process</td>
<td>Efficiency</td>
<td>Customer contact point defines the de-coupling point and efficiency</td>
<td>Flexibility</td>
<td></td>
</tr>
<tr>
<td>Logistic characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of intermediaries</td>
<td>Large</td>
<td></td>
<td>Small</td>
<td></td>
</tr>
<tr>
<td>Bullwhip effect</td>
<td>Prominent</td>
<td></td>
<td>Less likely</td>
<td></td>
</tr>
<tr>
<td>Supplier relationship</td>
<td>Regular, collaborative, high information sharing</td>
<td>Infrequent, opportunistic collaboration, more barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics processes focus</td>
<td>Efficiency</td>
<td></td>
<td>Flexibility</td>
<td></td>
</tr>
<tr>
<td>Supply Chain Strategic Capability</td>
<td>Lean</td>
<td>Leagile</td>
<td>Agility</td>
<td></td>
</tr>
</tbody>
</table>

Fig 2.11.1. Comparison of supply chain characteristics. Supply chain types are matched with a supply chain strategy depending on product, manufacturing and logistics characteristics (Stavrulaki and Davis, 2010).

A supply chain strategy can be either lean, agile or leagile with each strategy closely linked to the characteristics of specific supply chain types (Stavrulaki and Davis, 2010). Christopher and Towill (2001) highlight the connection between market qualifiers and market winners in relation to the supply strategies of lean and agile. Where cost is the market winner a lean strategy is best used. Agile supply strategy, on the other hand, is best used when service level is the market winner. High product quality is required for both lean and agile practices.

Christopher and Towill (2001) see opportunities with the use of several supply strategies where products can be differentiated by volume and variability and where de-coupling points can be used for holding of strategic inventory. Baker (2008) means that the de-coupling point separates lean from further downstream agile practices. Baker (2007) explains that both lean and agile strategies advocate low inventory levels. In lean strategies it is due to the mantra of removing waste whereas in agile strategies low inventory levels is a way for companies to respond faster to changes in customer demand.
2.12 Service / Quality

There is a need to align supply chain strategies of lean, agile and leagile with operational manufacturing and logistical processes usually either more effective or efficient in nature (Stavrulaki and Davis, 2010). Lee (2002) explains that an efficient supply chain focuses on cost by economies of scale, reducing non-value adding activities and optimisation of capacity utilisation. Factors influencing responsiveness are according to Chopra and Meindl (2013) ability to respond to demanded quantities, ability to handle a large variety of products, to develop innovative products, meet service levels, to meet short lead times and handle supply and demand uncertainties. Reichhart and Holweg (2007) mean that a more responsive supply chain is showing more of all these factors and also add compression of lead time as a factor influencing responsiveness. The authors’ definition of supply chain responsiveness is the speed at which the supply chain can respond to a customer order within the range of product, volume, mix and delivery. In practice however, Chopra (2001) explains, customers do not want full performance scores on all factors related to responsiveness. Instead, Christopher (2005) adds that the objective is to provide customers with the level of service negotiated or agreed upon. Service priorities are preferably done by a profitability analysis of certain customers or products and the Pareto Law can be used as a tool for such analysis and development of cost effective service strategy. Christopher and Towill (2001) argue that the Pareto Law can also be used to find distribution practices where 20 percent of the customers should be managed different from the other 80 percent. It is suggested using lean practices for the more predictable 20 percent and agile practices for the more volatile 80 percent.

Operational responsiveness in the supply chain relates to short-term changes in demand such as changes in product mix, product volumes or delivery sequence. In medium and long term responsiveness is more directly related to product changes (Reichhart and Holweg, 2007). Christopher (2005) means that responsiveness is depending on the two variables velocity and visibility; a clear view of real demand enables a more rapid response which is the basis for a more effective match between demand and supply. It is further explained that responsiveness is achieved by agility in the supply chain. To achieve agility in an organisation it is important with market sensitivity, network between logistical systems, virtual integration and alignment of processes and decrease supply driven by forecasts (ibid).

Both flexibility and responsiveness can be used to describe supply chains however there is a difference between the two as explained by Reichhart and Holweg (2007). Korpela and Lehmusvaara (1999) define warehouse flexibility as the
ability to arrange urgent deliveries when required, have flexibility in the frequency of deliveries, respond to any special request by the customer and respond to any changes in the warehousing capacity needs by the customer. Flexibility can be seen as a factor contributing to responsiveness in the supply chain and not the other way around (Reichhart and Holweg, 2007). According to Stavrulaki and Davis (2010) processes in a company should be more or less flexible depending on the characteristics of demand and volume. The authors discuss flexibility in terms of external flexibility which is related to customer orders and internal flexibility which is related to the manufacturing and logistics processes. Hardman et al. (2007) mean that companies need to ensure that they have the capabilities to understand the customer needs and flexibility to adapt to them.

2.13 Time

According to Christopher (2005) there are three significant reasons for why the market today is highly time-sensitive; shortening of product life cycles, focus on reduced inventories and volatile markets where heavy reliance on forecasts can be dangerous. Reductions in order lead time will improve supply chain responsiveness or agility and is therefore a customer service determinant as it directly influences customer service level (Gunasekaran et al., 2001; Gunasekaran et al., 2004). Short lead time is also important in efficient lean supply chains where it works by eliminating waste and thereby reducing costs (Baker, 2004). Hardman et al. (2007) explains that lead times must be optimised along the entire supply chain and be based on predictability of customer demand. The strategy is helpful in getting the product to the market faster and will also generate sales at full-price, both of which are measures of competitive success.

A problem many organisations are facing is called the lead-time gap. It means that the time to source, manufacture and deliver a product to customers is longer than the time customers are willing to wait (Christopher, 2005). Customers’ willingness to wait is influenced by the competitive environment and can vary between certain industries and products (Hardman et al., 2007). The common strategy to cover the lead time gap is holding of safety inventory and use of forecasts. One way of reducing the lead time gap without increasing inventory is by shortening the order cycle time (Christopher, 2005). Another option is by receiving earlier signals of demand requirements through inventory replenishment systems (Rushton et al., 2010). Frohlich and Westbrook (2001) argue that through supply chain integration systems, between customers and suppliers, the operational performance of inventory turnover, delivery lead time and dependability improves. A study by Korpela and Lehmusvaara (1999) show that
when customers were asked to prioritise service requirements in warehouse networks delivery time got the highest rating. In the research of Gunasekaran et al. (2004) on time delivery was second only to quality of delivered goods as the most important delivery performance measurement. Delivery lead time and on time delivery are thus essential service requirements to take into consideration in warehouse design (Melachrinoudis and Min, 2007).

Reduced cycle time from order to delivery is a strong competitive advantage over slower competitors (Gunasekaran et al., 2001; Christopher, 2005; Hardman et al., 2007; Baker, 2004). Short lead times are critical especially in agile supply chains where service is highly valued by customers. Lead times can be significantly reduced in activities connected to warehousing and distribution (Chopra and Meindl, 2013). The difficulty is, however, that the lack of visibility over the entire supply chain often means that opportunities for lead time reduction are not fully recognised. Reduction in order lead time is best managed holistically in order to reach full potential efficiency (Tompkins, 1991).

Several logistic activities will add more cost than value. Increasing value-adding activities will improve the logistic processes. Mapping of logistic pipelines is a very good basis for re-engineering projects since opportunities for reduction in non value-adding activities becomes noticeable (Christopher, 2005). Rushton et al. (2010) discusses how performing value adding activities in a warehouse can reduce lead time by performing the activities at a late stage in the supply chain. Compression of time by reducing non value adding activities can enable a way to eliminate the trade-off between cost and service since time compression enhances both (Christopher, 2005).

### 2.14 Cost

One reason why cost is so important is that it is reflected in the price of the final product (Rushton and Walker, 2007). The efficiency of the supply chain can be assessed using total logistics cost. It is used to determine the impact of a broad range of strategies and practices. Warehouse decisions cannot be based on one single cost driver and therefore such decisions require estimations on time spent on each relevant activity (Chopra and Meindl, 2013). The logistics system usually uses a great part of a business’ fixed assets (Christopher, 2005). Several authors have identified three total logistical cost drivers of supply chain performance which are facilities, transportation and inventory (Chopra and Meindl, 2013; Fisher, 1997; Baker, 2004; Rushton et al., 2010). Inventory and warehousing are significant cost factors, representing between 20-30 percent each of total logistics costs (Rushton et al., 2010). Theories of warehousing excellence often identify
costs related to order processing and costs of holding inventory as a trade off to cost of transportation. A breakdown of warehousing costs is done in figure 2.14.1, which demonstrates the importance of effective use of building space and staff in the design and operation of facilities (ibid).

**Breakdown of Warehousing Cost**

Fig 2.14.1. A breakdown of costs related to warehousing (Rushton et al., 2010).

The relationship between total logistics costs and its important components can be seen in figure 2.14.2. *Total logistic cost* considers the whole range of costs associated with logistics, including transport and warehousing as well as inventory carrying and systems costs. (Rushton et al., 2010). Total transportation cost includes *local delivery cost* from warehouse to customer and *primary transportation cost* which represent the supply from a production plant to a distribution warehouse. The *cost of holding inventory* includes the cost of capital tied up in physical stock, service cost with insurance and stock management as well as risk cost including damages and stock obsolescence. Warehousing and *storage cost* is dependent on size and number of facilities within the whole distribution network. Storage cost includes staff, facility, service and equipment. Information *systems cost or order processing cost* represents requirements for information and communication.

The minimum point at the curve total logistic costs, in figure 2.14.2, illustrate number of facilities to use at lowest overall cost; the minimum point depends on the service level aimed for, the geographic area of demand and type of product (Rushton et al., 2010). Number of facilities in a distribution network should be equal to the number which minimises total cost of logistics. An increase in facilities beyond this number will provide better responsiveness to customers. Improving responsiveness should be justified by improved revenues that outweigh additional costs from increased number of facilities (Chopra and Meindl, 2013).
Total logistics cost is influenced by the addition or removal of a depot in the logistics system. Consolidation of warehouses typically reduces warehousing costs and inventory carrying costs. Centralisation of inventory can be suitable when facility and inventory costs make up a large part of the supply chain’s total cost. When inventory is centralised at fewer warehouses the total cost of transportation generally increases. Although the cost of outbound transportation will increase, centralisation of warehouses leads to a reduction in inbound transportation (Melachrinoudis et al., 2005). Centralisation may also be preferable if customer orders are large enough to provide adequate economies of scale on outbound transportation (Rushton et al., 2010).

Transportation costs are also linked to the level of responsiveness provided. High responsiveness will result in small shipments with higher transportation costs. Decreased responsiveness can exploit economies of scale which results in lower transportation costs but larger shipments. Different customer needs may be met at lower cost if tailored transportation modes are used based on both customer needs and product characteristics (Chopra and Meindl, 2013).

Changes in one major element of the logistics system will affect other elements as well as the overall system (Rushton et al., 2010). Total cost savings can be achieved by savings in one activity; additional costs may be added but overall the costs may still decrease (Christopher, 2005). Rushton et al. (2010) illustrates this in figure 2.14.3 where the number of distribution centres in a distribution network is reduced. The result is an increase in local delivery cost but savings in other
elements (transportation, storage and stock-holding costs) leading to an overall reduction in total logistics cost.

![Diagram of logistics cost categories with initial and new configurations](image)

**Fig 2.14.3.** A distribution network changes in configuration by a reduction of distribution centres and total logistics cost is affected (Rushton et al., 2010).

A significant amount of a company’s total assets is often tied up in inventory (Christopher, 2005). In the warehousing function the coordination of both cost and time drivers must be balanced. One objective can be to reduce the time the capital is tied up in order to turn cost into profit. The cash-to-cash cycle can illustrate this balance and concerns the working capital invested in sourcing and producing a product until it is financed by received payment (ibid). According to Baker (2004) there seems to be a consensus in companies to minimise inventory costs. According to Gallman and Belverde (2011) there is a trade-off between inventory holding cost and stock availability. It can sometimes be cost effective to build up inventory in order to reduce costs elsewhere in the supply chain, for example to receive discounts on large quantity orders, build up seasonal stock or cover production cut outs (Rushton et al., 2010). Frazelle (2002) emphasises the complexity of holding safety inventory as too much inventory results in obsolete stock which can have significant cost consequences. However, the impact of not having stock available can be severe and ultimately drive customers from buying the product. This has led to pressure on the supply chain delivering on time but with minimal inventory (Christopher, 2005).
3. Problem Discussion

This chapter frames the problem covered in the thesis. Frequent areas of discussion from theory are highlighted and gaps in the literature are addressed. The research question guiding the work in the thesis is also presented.

The existing literature within supply chain management has covered its importance as a strategic level concept. It can be considered a core competence contributing to long-term performance in a company and between partners in the supply chain (Stank et al., 2005). Distribution network design and warehouse management are extensively studied in the literature where warehousing decisions are highlighted as a part of the distribution network design (Chopra and Meindl, 2013). The focus in literature has been on the competitive environment, customer needs and product characteristics as a basis for supply chain design (Fisher, 1997; Christopher, 2005; Rushton et al., 2010) The literature further cover the alignment of supply chain strategy with the competitive strategy (Fisher, 1997) as well as the importance of alignment between different strategies and decisions levels (Hoffman, 2010). It is recognised that supply strategies at lower levels should correspond to the decisions made at higher levels (Nollet et al., 2005). Distribution and warehousing theory have consequently been studied for some time stressing the importance of how the right optimising strategies can achieve functional excellence. However, supply chain management has not been fully extended into warehouse network design as addressed by (Baker, 2004) and in the literature there is a separation between supply chain and warehousing theory. Further information regarding at which level warehousing decisions are formed are limited. It is therefore of interest to study which supply chain drivers that affect warehousing decisions and the importance of warehousing in supply chain design.

At the studied case company there is a need for a restructuring of current distribution network, with focus on warehousing practices, as it is believed to solve some of the complexities experienced in the supply chain network. Current supply chain practice has created different constraints which lead to problems in the supply chain. Distributors, for example, often experience lack of product availability which they compensate by buying the missing goods from other distributors having the product on-stock resulting in unnecessary costs and administrational work. Current supply chain strategy has been adopted from the corporation and followed for a long time at the company and it seems no thorough previous attempts have been made to solve the problem. Before making any changes to the supply chain the company asks for more knowledge about
Warehousing strategies and suggested practical solutions. Further the case company does not make decisions of this magnitude without considering it together with the corporation. On this basis the thesis aims at developing a decision support tool for distribution network design in order to give an understanding of what supply chain drivers and which variables that affect warehousing strategies.

It is not uncommon for companies to redesign their warehouse strategy in order to reduce costs and taking advantages of economies of scale (Melachrinoudis and Min, 2007). Cost will always be critical in delivering the product but more effective strategies need to be developed in order to effectively supply customers with what they want (Hardman et al., 2007). Decisions and design of nodes and links in a distribution network is fundamental in the long term and will influence a company for a long time (Frazelle, 2002). Therefore change management programs need to consider both strategic and operational needs for the supply network design (Christopher and Towill, 2001).

Warehousing related problems can affect product availability. However, availability of stock does not necessarily mean that an order can be fulfilled (Baker, 2007). Similar to what the case company experiences a product may be stored at the wrong location or information stored may be inaccurate. Inadequate practices as well as technology and equipment can keep companies from serving the customer properly (Gallman and Belvedere, 2011). Supply chain integration initiatives, connecting manufacturing with consumers with the purpose of a more efficient consumer response, will probably never be so coordinated that warehousing can be completely eliminated (Frazelle, 2002). The lack of improvement in supply chain performance is due to managers needing a framework of which ideas and technologies that fit their specific company situation (Fisher, 1997). Although all supply decisions can be considered important for organisational performance some will be more critical due to their impact on the value created to customers (Nollet et al., 2005). Therefore it is considered important to develop an understanding of which areas that are important to consider for firms willing to make changes in its supply chain network. To frame the problem, how do supply chain decisions affect strategic warehousing network design. The literature review will serve as a review of knowledge for supply chain and warehousing theories covering the most recent research within the area. It is extensive but focuses on relevant theory for the main topic of the thesis: Decision Support System for warehousing strategies. To address the gaps found in the literature and clarify what will be done in the thesis a research question was developed. A research question makes a research more
precise and accurate; it serves as a guide for the researchers towards the right direction (Bryman, 2012). The research question for this thesis is presented as,

How should decisions regarding strategic warehousing be made?
4. Methodology

This chapter describes the chosen research design, research strategy and the collection of data used to perform the thesis. Further it provides a description of how the data collected have been analysed. The frequency table presented in this chapter serves as the foundation for answering the research question by identification of supply chain drivers and important warehousing strategy variables.

4.1 Research strategy and research design

The purpose of this thesis is to identify and investigate which supply chain drivers and specific variables affect warehousing decisions and how these are strategically important. The open-ended research question enables a flexible gathering of relevant data. The thesis is using a deductive approach to build on existing theory (Bryman, 2012). However, the development of the Decision Support System, where all data collection and data analysis are related into one core concept, is made with a concept building approach.

The project comprised a qualitative semi-structured interview together with the quantitative method of a survey. The research methods give a mutually illuminating contribution to the research question. The study is therefore performed with a mixed-method research strategy which is a combination of quantitative and qualitative data (Bryman, 2012). The reason a mixed method research was chosen is due to it offering an enhanced completeness and credibility to the thesis. Bryman (2012) discusses how the concept of completeness gives a more inclusive answer to the research question by filling the gaps left by using only one method. Further it is explained that credibility increases the integrity of results.

The thesis research question is formulated to investigate the problem description in depth and an explanatory case study design is chosen as it contributes with relevant operational links (Yin, 2009). The thesis is completed together with a case company operating in the textile and apparel industry which serves as a complement to the literature review. The case company is in need of a restructure of its distribution and warehousing network and in addition its current organisation structure adds constraints. The design of the research was therefore chosen to be a basic case study (Bryman, 2012). According to Yin (2009) the benefit of a single case study is that it gives a holistic view of the company highlighting how the functions of the company work together.
The original idea conducting the thesis was to compare the results from the literature review with empirical data collected from interviews. However, during the interviews it became apparent that it would be beneficial for the study if the respondents ranked supply chain drives and variables related to warehousing in a survey in order to highlight their relevance. The order of the data collection methods is thereby explained. The original idea was changed and the collected empirical data was instead used for building on existing theory.

4.2 Data collection

The data collection consists of a literature review which is used to complement a contemporary case study (Yin, 2009). Further, the methods interview, survey as well as observations through site visits and organisational documents were conducted in order to give a holistic view of a case study research.

4.2.1 Literature review

An extensive literature review was conducted in order to examine and understand the work of others in the field and to avoid repetition of existing research. Using existing literature is a way of developing an argument concerning the significance of the research chosen to be explored (Bryman, 2012). In order to delimitate the literature research important notes were defined serving as boundaries from where to gather and base the literature. The notes included mainly peer-reviewed articles with a focus on providing information and insight into supply chain management and warehousing strategy. In order to cover most recent research articles from 1990 and onwards were selected.

The University database Summon was used for the search of relevant scientific articles. Cited references found in the articles were used as secondary sources which yielded additional papers, business journals and books. It was noticed that several authors used reoccurring literature in their material which were added in the thesis literature review. The search for publications was conducted by a structured search of keywords. Examples of key words used were:

“strategic supply chain management”, “strategic warehousing planning”, “supply chain design”, “levels of decision making”, “warehousing research” and “distribution”.

Added to this were articles within supply chain management with a focus on the textile and apparel industry. The literature review was synthesised and interpreted which subsequently served as a basis for a quantitative research.
4.2.2 Interviews

Qualitative interviewing is favoured in case study design because this method is helpful in generating an intensive and detailed examination of a company (Bryman, 2012). A semi-structured interview was adopted which is according to Bryman (2012) an interview with basis in an interview guide however interviewees have the chance to answer the questions freely. A benefit of case study interviews is the ability to focus and target the topic directly which can provide insightfulness (Yin, 2009). The interview guide was developed with basis in the research question and from a brainstorming session the focus of the guide evolved. To create a flow the questions were ordered in a logical structure. All questions in the guide followed a consistent line of inquiry and were asked all respondents. The open structure however enabled a flexible interview set-up where relevant points were followed up depending on the answers given. See interview guide in Appendix A, presented in Swedish.

In order to make an in-depth study managers from different functions involved in the strategic decisions were selected for interview. The respondents selected represented different functions within the case company with the purpose of creating a holistic view based on information from several departments. The four selected managers consisted of the CEO of the case company, financial manager, export manager as well as logistics and purchasing manager. The interviews were conducted at the case company’s head office in Borås and held in Swedish. The length of each interview was approximately one hour. The interviews were recorded upon permission using a recording device. Subsequently the interviews were transcribed in Swedish.

4.2.3 Survey

In addition to the interviews the respondents were asked to answer a survey with the purpose of ranking supply chain drivers and variables deducted from the literature review, see survey in Appendix B. The purpose of the survey was to gain a more in-depth investigation of the case company. The survey is not intended to be quantified by making the sample represent a population.

An attached questionnaire (Bryman, 2012) was sent to the respondents by email a week after the interviews had taken place. The attachment also included a short objective explanation of each variable to decrease insecurity and increase response rate. See Appendix C for explanation of the variables. The respondents were asked to rank the supply chain drivers on a scale from one to eight. One represented the most important supply chain driver in decision making and eight the least important driver. The scale number allocated to each driver also served as a point which was summarised according to all respondents’ perceived
importance of said driver. The summary gave the drivers a value which made it possible to compare the supply chain drivers.

The same method was applied to the respondents ranking of the variables. The supply chain drivers are dependent on the variables identified in the literature review making these highly valuable to investigate. The interpretation of the results shows that the lowest value represents the most important driver and variable. This is because of the ranking method used to determine the pattern of importance association.

After one week with no responses a reminder was emailed to each respondent along with a further explanation of how to interpret the survey. The explanation included the following clarifications:
“1. The groups mentioned are incorporated in the supply chain flow. We would like to ask you to rank which groups you consider more important when designing your supply chain. 1 represents the most important, 2 the second most important and so on.
2. The variables are identified through a literature review and can be considered important aspects of warehouse decisions. They are thus related to distribution and the inventory holding points. We would like to ask you to answer which variables you deem important within each group. 1 represents the most important, 2 the second most important and so on.
3. If you feel that some important aspect is missing please add this/these in the allocated field.”

Once the additional explanation was emailed the responses were gathered within the week. No additional aspects were added by the respondents. See empirical study chapter 5, table 5.4.1 and 5.4.2, for summarised survey responses.

**4.2.4 Site visits and organisational documents**

Apart from the interviews and survey two site visits to the case company’s head office were made. It was done to gain an understanding of the organisation and familiarise with the company culture. During these visits organisational documents such as the corporation annual report from 2011 and organisational structures were accessed. The additional information has contributed to the findings of the case company presented in the empirical study chapter 5.
4.3 Data analysis

4.3.1 Frequency table
According to Bryman (2012) a theory concept in quantitative research has to be measured. Further the author explains that it is necessary to provide indicators that stand for the concept. Therefore and in order to find important indicators to consider regarding the concept warehousing an examination of scientific articles and analysis of their content was performed. The analysis resulted in a selection of four books and 19 articles. A scheme was carried out with the purpose to identify supply chain drivers and investigate in detail variables which influence the warehousing strategy. Evident from the literature review a number of concepts were frequently mentioned in regards to supply chain management. These important concepts subsequently served as supply chain drivers under which specific supply chain variables were aggregated. The supply chain drivers identified were: strategy, product, service/quality, cost, macroeconomic factors, time, distribution and information, all of which influence the design of the supply chain. Identifying the drivers was done with the intention to find different elements that impact supply chain decisions.

Looking into the concepts discussed within each driver different variables were identified and selected. The variables were coded based on frequency in literature and ranked in relation to each other by using a frequency table which, according to Bryman (2012), is a common format when using variables. The process resulted in an initial identification of 74 variables. Based on the summary of the variables a selection was made by picking the variables discussed most frequently by the authors. Subsequently the final process of selection included a synthesis of variables where different authors discussed the same topics but using different terminology. The process was based on interpretation of contents and reduced the number of variables to 30. Noteworthy was that no single variable was discussed by all authors. The purpose of the frequency table was to determine the most discussed variables within each supply chain driver. See table 4.2.1 for the frequency table, an explanation of the variables presented in the table can be found in Appendix C.

4.3.2 Coding procedures
Coding represents the way by which data is broken down, conceptualised and put back together in new ways. Analytic coding procedures are designed to build theory by generating a dense grounding for the theory and break through biases and assumptions (Strauss and Corbin, 1990). The analysis of data has been done through three different types of coding.
Open coding is part of the analysis that pertains specifically to the naming and the categorisation of phenomenon through the examination of data (Strauss and Corbin, 1990). The data collected from the literature review was analysed and the concepts identified were compared and classified when pertaining to a similar phenomenon. Once the conceptualising of the data was done by comparing the variables those representing a similar concept were grouped and categorised in supply chain drivers. The categorisation of the variables was based on the context in which the variables and drivers are mentioned in the literature.

The raw data from the interviews were transcribed and cross-analysed by the authors using open coding where the data from the empirical study was categorised using the supply chain drivers.

Axial coding is a procedure whereby data is put back together in new ways after using open coding (Strauss and Corbin, 1990). Axial coding is presented in the analysis where a new connection between the variables is made using three decision levels. Through axial coding focus is on relating the variables to suitable decision levels based on the causal conditions, context, interactional strategies and consequences of these relationships (Strauss and Corbin, 1990). The case company contributes with the context thereby facilitating in the allocation of each variable to a decision level. Axial coding gives another dimension to the data for managing and handling data in a systematic way (Strauss and Corbin, 1990).

Finally for the development of the Decision Support System selective coding was used by systematically relating all concepts from previous coding to the core concept of how strategic warehousing decisions should be made (Strauss and Corbin, 1990). By using selective coding the relationships identified between supply chain drivers, warehousing variables and decision levels are integrated and validated in regard to the central concept of the study. The selective coding enabled a final analysis in the thesis and theory development of the Decision Support System.
Table 4.2.1. Frequency table presenting the eight supply chain drivers and corresponding distribution and warehousing variables.

<table>
<thead>
<tr>
<th>AUTHORS / VARIABLES</th>
<th>Strategy</th>
<th>Product</th>
<th>Service / Quality</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supply Chain Understanding</td>
<td>Company competitive strategy</td>
<td>Strategic fit</td>
<td>Integration along the supply chain</td>
</tr>
<tr>
<td>Baker (2005)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chopra (2003)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chopra and Meindl (2013)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christopher (2005)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish (1997)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fransoo (2000)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guijarro and Bolvado (2011)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higgins and Brown (2006)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jorgensen and Schonberger (1993)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melachroinos et al (2005)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melachroinos and Min (2007)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napolitano (1995)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schöpp (2009)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaamali and Davis (2009)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woiwode and Tiro (2004)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2.1. Frequency table presenting the eight supply chain drivers and corresponding distribution and warehousing variables.
Table 4.2.1. Continued. Frequency table presenting the eight supply chain drivers and corresponding distribution and warehousing variables.

<table>
<thead>
<tr>
<th>SUPPLY CHAIN DRIVERS</th>
<th>Macroeconomic factors</th>
<th>Time</th>
<th>Distribution</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTHORS / VARIABLES</td>
<td>Macroeconomic factors</td>
<td>Lead-time / Cycle time</td>
<td>Delivery lead time</td>
<td>Value adding activities</td>
</tr>
<tr>
<td>Baker (2007)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Baker (2008)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chopra (2001)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chopra and Meindl (2013)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Christopher (2005)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fisher (1997)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Frazelle (2002)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gallman and Belvedere (2011)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ganasekaran et al (2001)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hardman et al (2007)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Higginson and Buschbinder (2005)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Korpela and Lehmsvaa (1999)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Melachrinoudis et al (2005)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Melachrinoudis and Min (2007)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Napoliano (1997)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rehauzen et al (2012)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Schipper (2000)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Stavroulakis and Davis (2001)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 4.2.1. Continued. Frequency table presenting the eight supply chain drivers and corresponding distribution and warehousing variables.
4.4 Research Quality

4.4.1 Reliability

Reliability measures the consistency of a concept and is therefore concerned with whether a study is repeatable (Bryman, 2012). In other words, how well are the used methods documented in the thesis and thereby enabling other researcher to repeat the study. The method is well explained and documented to provide an understanding of the research process. The interview guide and the survey are provided in the thesis Appendix for inspection. In addition, the raw data collected through interviews and the survey are available for inspection upon request. According to Yin (2009) a case study database increases the reliability as it can be reviewed if necessary.

A few circumstances affect the repeatability and result of the research process. Since the nature of an industry changes a company is constantly developing thus changing the prerequisites of the data collection (Bryman, 2012) and therefore current setting of the case company observed for this thesis might be hard to recapture.

In the survey a data-collection error (Bryman, 2012) occurred as one respondent was unable to rank five variables within the supply chain drivers distribution and information. The reason might be that the respondent was unfamiliar with the concepts. No further information was given as the aim of the survey was to neutrally reflect the case company’s view of important aspects in its supply chain. However, the effect of the data-collection error was limited in the results as the supply chain drivers distribution and information were extensively covered in the interview discussions.

4.4.2 Validity

Validity concerns whether the concepts chosen for investigating the subject is appropriate for the research question and whether the integrity of conclusions generated from the research is accurate (Bryman, 2012). In order to establish validity there are three different concepts which need to be considered; construct validity, internal validity and external validity (ibid).

Construct validity reflect the degree of which the data used in a study is measuring the chosen topic of research (Bryman, 2012). In the study construct validity refers to how well the Decision Support System measures how decisions regarding strategic warehousing should be made. Multiple sources of evidence in the data collection, combining both quantitative and qualitative methods, have
served to illuminate the area of investigation. The quantitative method with the frequency table helped in identifying the supply chain drivers and corresponding variables. The qualitative method using interviews, helped in examining the drivers and variables importance facilitating the categorisation of variables in the different decision levels. The interview respondents were selected based on management positions in the case company and have extensive knowledge of the organisation and the constraints experienced in the distribution network. The mixed method research therefore created a holistic data collection resulting in the Decision Support System which can be used to appropriately answer the research question.

Internal validity is concerned with whether there is a close relationship between the developed ideas and observations made by the researchers (Bryman, 2012). In the study internal validity refers to how the results of the study are related to the study of articles and documents as well as observations made in the interviews. The frequency table can be considered the foundation for this study as all other methods are based on it. The selection process of relevant articles and books has been as objective as possible however subjectivity of a researcher is hard to eliminate. In this case, data for the frequency table was collected using the database Summon making the data research limited to its available literature. The identification of supply chain drivers and variables were primarily based on literature. Concerning the variables different authors discussed the same topics but using different terminology therefore reduction of the variables were necessary. The reduction was done using open coding pattern matching. These processes were all done through interpretation of contents making subjectivity difficult to eliminate. However a cross-analysis between the thesis co-authors increased the internal validity of the selection.

In the Decision Support System variables are matched with different decision levels. A majority of the variables could be classified using literature but a few needed to be interpreted using axial coding based on when and how it impacts the supply chain. Cross-analysis of information helped in reducing such subjectivity.

When conducting qualitative interviews the researchers are present and will therefore affect the interview circumstances. The researchers also affect the data collection as different persons interpret situations differently (Yin, 2009). Different researchers will therefore receive different information from the respondents. In order to increase internal validity each transcribed interview was sent to the interviewees for approval. No interviewee commented on the transcriptions which can be an indicator of high validity. Cross-analysis was conducted regarding the interviews as well.
External validity, or generalisability, concerns whether the results obtained from a study can be used beyond the context of where it is conducted (Bryman, 2012). In the thesis external validity refers to if the results can be applied to other industries as well as other companies. According to Bryman (2012) criticism against single case studies is that they cannot be generalised. However the case company’s characteristics strongly correspond to the description of textile and apparel industry in general. Therefore the Decision Support System can be generalised within the textile and apparel industry and applied to companies operating in the specific industry.
5. Empirical Study

This chapter presents the findings obtained from the case company interviews and survey. To begin with a background to the case company’s situation is presented. The supply chain drivers identified are used for structuring the case company’s current situation in eight sections; strategy, product, service/quality, cost, macroeconomic factors, time, distribution and information. A description of problems and constraints in the current supply chain structure are provided in the final sections of this chapter followed by a presentation of the data obtained from the survey.

5.1 Background

The case company was founded 1973 with focus on producing base layers and functional sportswear for the Scandinavian market. In 1996 the case company was acquired by a larger corporation after going bankrupt for the second time as a result of a failed product strategy. Today, the corporate group consists of three operating segments; corporate promo, sports & leisure and gifts & home furnishing, each with a number of subsidiary brands. Sales within the corporation were in 2011 divided on the different segments as follows; 43 percent of sales from corporate promo, 41 percent from sports & leisure, and 16 percent from gifts & home furnishings. Central to the corporate group is the entrepreneurial CEO whose strategy has been to expand the business through acquisitions and mergers.

The case company’s focus has remained on functional sportswear but sales have grown considerably since the acquisition by the corporation. Originally the corporation focused on the segment of corporate promo, selling mainly through business to business with only a small part being sold through retailers. In step with the case company’s growth the interest for the sports segment as well as interest for sales through retail within the corporation has increased. The case company is currently present in 38 markets globally. 27 of these markets are classified as external distributors. The remaining 11 markets belong to the corporation group and are therefore called internal. The use of internal distributors derives back to when the case company was acquired and the corporation already had a presence in European markets through internal distributors. These distributors had knowledge and sufficient size to gain markets shares in the sport apparel segment as well as the required financial stability, the set up was therefore left unchanged. External distributors are, however, located all over the world.
The respondents describe the sportswear market as immature especially from a logistical perspective. The main focus for retailers in the market is brand image and pricing making all other aspect such as delivery quality secondary. There has been a shift toward more focus on logistics but the changes are described as slow moving. There is also a tendency of market saturation resulting in an over production of goods which has lead to frequent sales and consequently a number of companies going out of business. Ensuring sufficient profit margins for distributors is also mentioned as a requirement in the market. Finally, sales within sportswear are described as highly dependent on the turn out of the seasons which also makes the forecasting process difficult.

5.2 Current situation

5.2.1 Strategy

A strategy within the corporation is to transfer its values to newly acquired companies making the values a guide for decision making. The case company’s business plan is developed and presented for the corporation board to judge the feasibility of the contents. The corporation is involved in decision making based on the magnitude and impact of the decisions in the case company and financial investments need to be approved by the corporation board. The corporate strategy is however described as decentralised by all respondents, leaving many decisions to the brands themselves. With the main focus on business to business in the corporation building a retail brand has previously been difficult for the case company. The case company explains that being part of a large corporation sometimes creates complexities but it has as well benefits. Since the case company has been profitable for several years it has lead to increased independence within the corporation by project funding. The annual report for the corporation states a vision for the case company to become an international functional sportswear brand. Decisions regarding design and product development are always managed by the case company itself. There is, however, a desire within the corporation to reach synergies between the different brands and segments by integrating purchasing, marketing, warehousing and distribution of assortments.

The case company has competitors which overlap on certain sport activities, for example one competitor might be specialised in running gear but not in cross country skiing. There is hence no direct competitor but rather a number of them depending on the area of sport focus.

The division of sales channels in the sports segment is estimated to 30-35 percent being sold through business to business and the remaining part sold through
The case company has chosen to regard the end consumer as the main customer especially within the process of product development. However, in the retailing sales channel there are in reality three categories of customers; distributors, independent retailers and finally the end customer. A corporate strategy is to focus on the customer and having all functions strive to increase the customer value. This is regarded as requirement in order to be successful within the corporation.

The end consumers are sports loving people at all levels ranging from a sport nerd living his or her life through sports to people making their first run. The end user of the case company’s products is further described as more competitive than the average active person with high demand regarding quality, function and fit. He or she is prepared to pay a higher price for the product. Although some products offered are more technical these are not targeted to a certain level of performance.

Retailers choose to sell products from the case company due to the high stock turn of products as well as high profit margins. It is estimated that retailers generally select between 5-10 percent of the total collection of garments developed for each season. The base layers representing the company’s core products rarely go on sale at the retailers as these products have long life cycles and high throughput in the stores. The more sport specific products often generate some degree of sales at the retailers’.

Distributors choose to cooperate with the case company because the brand is constantly evolving enabling the distributors in turn to develop their business. Distributors also value the profits they make from the case company’s products. The case company has a target turnover worldwide which is based on the different distributors’ business plans and expectations. The distributors have to fulfil requirements set up by the case company which has implemented a plan of how to support the markets in reaching the targets. In order to become and remain a distributor of the case company’s products there are a few requirements to follow. A distributor is required to purchase a certain product volume and have a certain budget to spend on marketing efforts. Distributors should also have a sufficient financing ability in order to ensure the case company’s desired level of growth in the market. A sufficient financing ability is as well necessary to make sure no problems arise regarding payments of goods. If a distributor fails to meet the requirements it runs the risk of being replaced. This has yet to happen and only on one occasion has an internal distributor been changed to an external. According to one interviewee potential new distributors are commonly external.
Historically the backbone of the corporation has been to be situated as close to the customer as possible and the warehousing strategy in the corporation is described as very basic. The aim has been to deliver products within one day which has resulted in the decentralised warehousing structure with depots in almost every market. The strategy stems from the segment of corporate promo and the sales channel business to business where large volumes need to be available at a moment’s notice. A total of eleven European markets are served through seven internal distributors belonging to the corporation. These markets/distributors are:

- Sweden and Denmark are sharing distributor
- Norway as one market has its own distributor
- Germany and Austria are sharing distributor
- Benelux, three markets are sharing one distributor which is located in the Netherlands
- Switzerland is one market with its own distributor
- UK is one market with its own distributor
- Italy is one market with its own distributor

The 38 markets where the case company is present, both external and internal, are divided into A, B and C markets where different strategies are employed according to possibilities for growth. Since around 20 percent of the distributors stand for 80 percent of the sales turnover those 20 percent are considered being the most important distributors. Ten markets are classified as A-markets with six of these being internal distributors and four external. Sweden and Norway are the most profitable markets followed by Benelux, Germany and Austria. Important countries with growth potential receive increased market resources. The case company thereby create conditions for increased sales by injection of money aimed for processing the market. The largest and most important distributors are also involved early in the development process of the case company’s collections. The focus markets help reducing number of styles in the collection based on their knowledge about sales in the markets. Even though the European distributors are considered internal they are self-supported and considered experts in their specific market.

In the business to business sales channel sport clubs choose the case company’s products mainly due to its product quality. The case company’s focus on a few sports and being experts at these sports increases credibility. Customers of the business to business channel value product availability and fast deliveries. The case company is also considered easier to deal with, due to its smaller size and quick decision making, compared to larger competing firms. Respondents further express that high inventory levels within the corporation have generated product availability which has been beneficial especially for sales through business to
business. Being a company operating in the sportswear industry the case company describes itself as unique because of its large sales in business to business.

5.2.2 Product

The case company is working with two collections per year, spring/summer and autumn/winter. The product range is divided into five categories with each category consisting of three functional layers. Layer one, also called base layers, and layer two can be used for any sport. Layer one is a core product for the case company and can be found in thicker as well as thinner qualities. Layer three is sport specific and divided into bike, run, cross-country skiing and alpine skiing. The different layers have different product life cycles spanning from four months to four years. Normally layer three has the shortest product life cycle where for example cross-country skiing and alpine skiing products represent pure autumn/winter categories with a life cycle of one season. The base layers represent the longest product life cycles. Base layers are also considered most profitable since they are cheaper to produce and as well can be produced in large volumes. Large volumes and few variations are expressed as optimal from a profitability point of view however in order to be successful there need to be products standing out each season. For the remaining products, profitability varies depending on cost of production and sales price at the retailers. In order to achieve economies of scale on fabric the case company tries to use the same material for several product styles.

When moving into a new market the strategy is to first introduce the base layer concept. It is done in order to break the market and as a result these base layers are sold everywhere the company is present. There are also plans on looking into more cross-functional products which can be used for more than one sports activity as well as increase the degree of trendiness to the garments.

5.2.3 Service / Quality

Product availability is considered very important within the corporation and a 100 percent service level is strived for. Having all products available at all times eliminates the risk of missing an order. Logistics is considered very important to accommodate replenishment of products at distributors and retailers. Customers have come to expect all products to be available at all times. Educating the customer in understanding that product availability for all product styles is not always possible is considered a long term goal for the case company.

5.2.4 Cost

Normally payment of goods is made by each distributor directly to the supplier, creating a financial relationship between the two. The distributors must pay for
cost of production in order to get access to the ordered goods. The distributor also pays for the delivery from production to distribution centre. Occasionally the supplier does not trust the distributor and in such cases the case company acts as a middle man paying the supplier. By doing so the supplier receives the money and the case company invoices the distributor thereby taking the risk for the distributor’s payment. However, payment of base layers is entirely handled by the case company subsequently invoicing respective country.

The distributors pay a brand fee, or royalty, in order to receive the rights to sell the case company’s products. By receiving information of the paid order volumes from the supplier the case company can monitor and regulate the brand fee invoicing for each distributor.

Trade between internal distributors is centrally controlled by the corporation. Directions for such business are very clear and based on product pricelists building on what previous distributor paid for the goods. Transportation costs are always paid by the purchasing part.

5.2.5 Macroeconomic factors
All internal distributors are situated in the European region. However, Norway is not a member of the European Union and there are many shipments of goods sent between the Swedish and Norwegian warehouses as these countries are the case company’s main markets. Since the Swedish warehouse is a bonded warehouse the goods become dutiable the moment they are sold from the warehouse. Therefore, sending goods to Norway outside the European Union does not add any extra expenses except administration costs and cost of distribution paid by the Norwegian distribution centre.

5.2.6 Time
Lead times are described as very important for the case company and continuous improvements of the lead time are an ongoing objective. Lead time reduction is mainly done through improvements of the forecasts made by the distributors. The main part of production is held in Asia however 80 percent of the base layers are produced by European suppliers. Product lead times range from 100, 120 or 140 days which affects delivery dates. Lead times are dependent upon the garment production process as well as the production of fabric. For a production lead time for example of 120 days the fabric lead time accounts for 35-40 days.

5.2.7 Distribution
Each distributor is responsible for forecasting, warehouse operations as well as inventory holding systems and sales. There are no requirements from the case
company of how logistics and distribution should be managed with the result of some distributors holding warehouse operations in-house and others leasing warehouse space through 3PL. Inventory holding is managed differently where some distributors use manual lists and some use highly automated data systems. However, since all internal distributors work in the same information system their control of warehouse operations are similar.

Further, the internal distributors have different capacity utilisation of warehouse space. There are those outgrowing their warehouses, others which have recently moved to larger facilities as well as some distributors experiencing overcapacity. However, the exact capacity and effectiveness of internal distributors’ warehouse operations are unknown to the case company. Regarding the external distributors the case company has no knowledge of their utilisation of warehouse capacity and, since these distributors are external, the case company does not express much interest in measuring it either. However, the case company must make sure that required documents are provided on time for all distributors in order to ensure an effective handling of goods. The distribution centres are not brand specific but shared within each segment of the corporation. Each internal distributor is holding products from the case company as well as brands offered from the different segments within the corporation. When asked whether the distributors hold brands from outside the corporation the respondents answered differently with some claiming that they do and others claiming the opposite.

Each distributor is responsible for arranging its deliveries from supplier to warehouse and decide themselves what carrier to use. Products are picked up from ports in Asia or from the suppliers in Europe. It is in the distributor’s interest to gather products from several suppliers into one delivery and as well consolidate products from the different brands of the segments’ in the corporation into one shipment. The purchase offices also help to consolidate loadings, shipments and transportation of brands within the corporation when possible in order to keep administration costs low. Products transported from Asia are delivered free-on-board (FOB) and within Europe products are delivered free-carrier. For goods going to internal distributors with FOB deliveries are arriving either in Rotterdam or Gothenburg. From these ports the goods are redistributed to respective distribution centre. Goods arriving at the distributors’ warehouses subsequently need to be distributed from the warehouse to retailers.

Since some products are weather dependent it can lead to capacity constraints at the distribution centre and retailers. Such seasonality problems occur because orders are placed ahead of season as a result of the long production and delivery lead times. In addition, the first orders of a season are usually larger to secure
product availability and late order entries. If the weather leads to decreased sales or if no late order entries are placed, it is necessary to take immediate action trying to “activate” the products already on stock in order to decrease obsolete inventory. Activation of seasonal products on stock has been improved at the case company and current policy is to check seasonal products after three to four months from arrival. This enables immediate action for slow movers through lowering of product prices or by pushing products out to the stores, in order to reduce inventory held at stock. The respondents further express that it is a balance between having products available but trying not to hold inventory. The optimal scenario is described as having the warehouse empty from April to August and only refilling it when demand arises. Basic products on stock mainly affect liquidity and tied up capital since these products work for several seasons. Even when the design of a base layer is altered retailers still purchases the old base layer for lower prices since the product still sell. There is great difference for basic and seasonal garments.

If actual sales are higher than calculated forecasts, internal distributors contact each other to check product availability at other distributors’ warehouses. Since each distributor owns the goods at the warehouse other distributors are allowed to buy when possible. Each distributor is responsible for sales at the market and left over or overstocked goods can be sold to other distributors in need of the goods. Each distributor is responsible for stock related problems at their distribution centre. One respondent mentions that there is an ABC-categorisation employed within the segment of corporate promo but the categorisation is used mainly for determining stock locations. A-items are held decentralised at all distributors while C-items are placed centrally.

5.2.8 Swedish distributor
The Swedish distribution centre serving the segment of sports and leisure was built between 2007-2009 and is approximately 19000 square meters. The distribution centre is managed in-house where 65-70 percent of the warehouse capacity is utilised by the case company. Further, there is one warehouse planner for each brand at the distribution centre. Evident through the interviews is that there is not a mutual warehousing strategy between the different segments in the corporation although freeing up long term storage space in each other’s warehouses does happen.

If manufacturers demand a certain product quantity for production that is not filled by the distributors’ orders the case company might still make an order and place the excess goods in the Swedish distribution centre. As well, since it is too costly to deliver very small orders separately to each distributor larger orders are
split in the Swedish distribution centre and subsequently sent to each market in smaller deliveries. The Swedish distribution centre can therefore be considered a global warehouse serving all markets. Further, the Swedish distribution centre holds a basic assortment called on-stock. The on stock assortment should always be available at the distribution centre but the assortment is primarily held for the Swedish market.

The inventory value at the Swedish warehouse has decreased around 30 percent in line with a decrease of inventory stock of around 30 percent over the last two years. The case company express that the decrease comes from actively working with improved inventory management compared to two years ago. The Swedish warehouse has an inventory turnover of 2.4 and a stock value of 110 million SEK. It is believed that the lowest inventory turnover is below one at a few distribution centres of the internal distributors.

5.2.9 Information

The case company has implemented an enterprise resource planning (ERP) system which is connected to a purchasing system used by the whole corporation. The purchasing offices around the world as well the case company’s head office enter information into the purchasing system regarding purchase and production orders, manufacturing and deliveries. The case company uses the purchasing system mainly to keep track of products in the supply chain. The internal distributors have access to the purchasing system and use it for their planning. They are as well able to place orders directly into the system however at present this is not fully used. Instead the internal distributors are placing the orders using an Excel template which is sent to the head office. The external distributors do not have access to the purchasing system and are therefore also using Excel templates when placing product orders. A policy within the corporation is to eliminate external use of the internal information systems. The order entry starts when the case company sends out Excel order templates to distributors.

It is the distributors’ responsibility to forecast sales as well as amount and value of products to purchase. Ultimately it is the sales manager on each market that has responsibility for the amount and products to order. The forecasting process is very important and made several months prior to order entry. It is primarily based on statistics from previous seasons. The sales of the season are weather dependent and can therefore vary greatly between years where a good or a bad winter impact sales more than other seasons. Therefore a more accurate forecast is also dependent on product knowledge and sales instinct.
Order entry is held 11 out of 12 months in a year as no orders are entered in July. Not all products are available at each order entry as it varies with product category. Each product has a specific lead time which determines the time for order entry. Layer one products can be ordered ten times per year whereas for layer two and three it is possible to make six or eight order entries per year. Each country specifies its orders and sends the Excel file back to the case company’s head office where all orders are collected and compiled. The case company is working with two collections per year and in line with that warehouse inventory levels peak twice a year. Efforts to smooth out these peaks have been made by increasing number of order entries. However, the distributors are still entering most orders in September and March as they are used to only two order entries per year.

The head office communicates with the purchasing office in Asia to decide what can be produced, as minimum product quantities are required for production. The purchasing office in Asia then punches the orders into the purchasing system which makes the total order official. The information entered in the purchasing system is picked up at the head office in Borås and used for creation of an order book presenting all approved styles. The order book is sent to the distributors together with order confirmation and cancel-list. When the official orders are reaching the suppliers, it is the suppliers’ responsibility to confirm the order with each distributor. Further each distributor need to accept the order and confirm delivery dates. Communication regarding order confirmation is solely held between supplier and distributor. When the orders are approved the order entry process is finished.

The production process is monitored by the Asian purchasing offices whereas the production process in Europe is monitored from the case company’s head office in Sweden. This set up enables quick response if something goes wrong or problems arise in production. If a problem is detected, communication goes through the case company which is able to inform the different distributors about the problems for example regarding late deliveries.

5.3 Problems experienced

The problems and constraints experienced by the case company regarding the distribution and warehouse network is mainly concerning internal distributors within the corporation.

There is no overall warehousing strategy for the corporation or the case company. One major concern with current warehousing set up is how the corporate strategy
of being able to deliver quickly has resulted in large volumes of inventory at the depots. This means a significant amount of tied-up capital which has become hard to finance. If several distributors fail in their forecasts the same type of product or products are kept as unsold inventory in several warehouses around Europe tying up capital on many locations.

Another problem expressed by several respondents is the shipment of products between internal distributors. It is described as time consuming with significant effort spent on discussing and arranging transportation including a lot of correspondence. There are also additional transportation costs and administrative costs which accompanies these transactions. Another major concern is the degree of service being inadequate as availability is not fulfilled in the warehouses. One respondent states that products within the corporation are exchanged daily between internal distributors in Europe with not just the case company’s products being exchanged. 35 million SEK is mentioned as an estimated cost for transporting goods between the internal distribution centres. The corporation is afraid to miss an order due to out-of-stock regardless if the product is selling 200 or 70,000 per year. Noteworthy is, however, that not all respondents believed this to be a problem. One interviewee mentions that the case company is not in fact transporting as much goods as it believes it is.

Through the corporate strategy of product availability an additional problem has surfaced affecting the case company. All distributors purchase products based on their own forecasts and budgets which has led to an unwillingness to share and sell products between markets. Operating as independent entities has made the distributors mainly concerned with their own budgets and sales targets, leading to distributors becoming protectionists something described as both ineffective and harmful to the company. There is also an expressed concern over the desired involvement of internal distributors in the case company’s decision making.

The exchange and flow of information is described as a concern by several respondents. When communicating with supply chain partners the information system seems insufficient and inflexible. Internal distributors do not fully use the existing system or has no interface implemented. Order placing is done in Excel and the manually handling of Excel templates is described as time consuming and unreliable. In addition the system implemented does not monitor inventory levels in the internal distribution network. As well, the system does not register when a distributor is checking for possible product replenishment with the case company. As a result it is unknown how often the case company is unable to fulfil an order. If the product is not available another item is offered instead. Several respondents
explain that there is a need for a better information flow hoping that this might enhance the case company concept by integrating the supply chain actors.

The respondents expressed an interest in redesigning the warehouse structure to fewer depots in Europe. One respondent describe how retailers have optimised their storage areas to ensure more available space for products in the stores. One example is given of a large sport goods retailer which has centralised its warehousing function with the purpose of daily dispatches of replenished products to the stores. This is putting pressure on logistics. Possible benefits with fewer distribution centres are explained as cost savings on facility, transportation and labour. One respondent discussed how eliminating the outsourced distribution centres additional cost benefits could be gained. In addition centralised warehousing could offer the possible improvement of increased product availability as well as a higher inventory turnover rate. One respondent mentions the risk of losing the personal touch with the customers if a changed warehousing network but overall the respondents are adamant that the benefits are greater for all actors. In the future there is also a desire to start online retailing which would create the possibility to offer all available products to the customer.

5.4 Survey

The outcome of the case company’s perceived importance of drivers when making decision regarding supply chain design is illustrated in table 5.4.1. The supply chain driver with the lowest summarised survey results represents the most important element. Table 5.4.2 shows the variables ranked according to their relative importance within each supply chain driver considering distribution and warehousing decisions. Within each driver the variables with the lowest summarised survey results represent the most important element.

<table>
<thead>
<tr>
<th>Supply chain drivers</th>
<th>Survey results summarised</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Product</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Service / Quality</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Cost</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Macroeconomic factors</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>Time</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Distribution</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Information</td>
<td>18</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 5.4.1 Survey data of supply chain drivers summarised and ranked according to perceived relative importance making supply chain design decisions.
<table>
<thead>
<tr>
<th>Supply chain drivers</th>
<th>Variables</th>
<th>Survey results summarised</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>Supply chain control</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Understanding customer need</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Company competitive strategy</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Strategic fit</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Integration along the supply chain</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Product</td>
<td>Product variety and characteristics</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Product volume</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Product life cycle</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Service / Quality</td>
<td>Responsiveness</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Delivery performance</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Cost</td>
<td>Total logistics and distribution cost</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cost of facility</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Cost of holding inventory</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Cost of transportation</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Cash-to-cash cycle time</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Macroeconomic factors</td>
<td>Macroeconomic factors</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Time</td>
<td>Lead time / Cycle time</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Delivery lead time</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Value adding activities</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Distribution</td>
<td>Role of the facility</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Location of facility</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Capacity utilisation of facility</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Average inventory</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Product stock availability</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Information</td>
<td>Forecast accuracy</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Demand information</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Information infrastructure</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Information efficiency</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.4.2. Survey data of variables summarised and ranked according to perceived relative importance considering making distribution and warehousing decisions.
6. Analysis

This chapter combines theory of distribution and warehousing as well as strategy and decision levels from the literature review. Current practices at the case company are discussed with support from literature. The findings are used for developing the Decision Support System presenting which supply chain drivers and variables that are considered strategic, tactical or operational. The definitions of decision levels are mainly based on chapter 2.3 and the survey results can be found in chapter 5.4. In the final section of the chapter the Decision Support System is applied to the case company leading to recommended solutions for improving the performance of its current warehouse practices.

6.1 Analysis of current situation

The empirical study revealed that the case company is experiencing constraints in its current distribution and warehousing network. One problem derives from a strategic mismatch between the case company and the corporation. The case company is an independent business unit in a large corporation. Although the organisational structure of the corporation is decentralised the corporation values are expected to be transferred and used as guidance in decision making in all business units. A supply chain strategy at the corporate level may seek synergy effects by coordination of activities (Hoffman, 2010). This is attempted by the corporation by integrating activities such as purchasing, distribution and warehousing between business units. As a result the supply chain strategy employed in the case company is influenced by the corporation set up. This presents a fundamental problem since the corporation and the case company mainly use different sales channels. The case company explains that being part of a large corporation not only creates complexities it has as well several benefits. Since the business unit strategy determines how a company competes (Hoffman, 2010) it is relevant to question where in a corporation, consisting of several business units, competitive strategies are formed. At present there does not seem to be directions over which decisions should be taken at the corporate level and which should be taken at the business unit level.

When the case company was acquired the corporation was established in the European market through internal distributors. The distribution and warehousing set up was subsequently adopted by the case company. The distribution network is decentralised with each internal distributor operating independently in regards to planning, forecasting and warehouse operations. The distributors also have individual budgets, however, sales targets are determined at the business unit
level. The internal distributors show signs of protectionism of their own operation and seem less concerned with the overall success of the different business units in the corporation. The case company experience the lack of common goals and integration of the internal distribution network to be a problem. The integration of internal relationships through common goals is important for improved logistic performance (Rodrigues et al., 2004). The corporation has designed its distribution network to ensure the highest service level through product availability and quick deliveries. However, due to inaccurate forecasts by the distributors orders cannot always be fulfilled but the relevant products may be stored at other distributors’. Hence, availability of stock in the distribution network does not make the case company fulfil orders since the products are stored at the wrong location. Given the wide variety of products available in the textile and apparel industry (Christopher et al., 2004) high stock availability at all distribution centres are difficult to maintain and manage. Currently, inadequate distribution and warehouse practices keep the case company from properly serving the customer.

The survey results, found in chapter 5.4, can depict the optimal position for a company in the textile and apparel industry. Since the case company operates in this specific industry the results from the survey can be influenced by its conditions. However, the interview data, found in chapter 5.2 and 5.3, is a description of the case company’s actual situation. The differences between the optimal position and the current situation are compared when possible in the following sub chapters and analysed together with the decision levels.

6.1.1 Strategy

Within the supply chain driver strategy the case company has ranked understanding customer need as the most important variable. This is consistent with theory which states that understanding customer need is fundamental to being a successful company as this is a driver to why the product is procured. The variable company competitive strategy is ranked second which highlights the importance of distinguishing from competitors by offering a unique value mix. The supply chain control variable was ranked third. In a distribution and warehousing network the desired level of control can be managed through decisions regarding an in-house or outsourced warehouse operation. The Swedish warehouse is managed in-house allowing the case company to control operations. However, the internal distributors manage warehouse operations differently where some hold it in-house and other lease through 3PL. The ranking of the variable could be explained by a desire to gain more control over the internal distribution network including warehouse operations. Keeping the warehouse function in-house can increase the competitive advantage as it can be controlled and aligned
with the company’s overall strategy. Strategic fit and integration along the supply chain have received the lowest ranking within the driver. There seems to be a lack of strategic fit between the strategic objectives of the case company and the corporation as strategies at the different levels are not aligned. In terms of supply chain strategy the corporation favours a set up with independent distributors whereas this does not entirely fit the case company’s distribution process. It has led to constraints which has created inefficiency in the supply chain. Integration of supply chain partners and functions can lead to improved logistic performance. However integration is easier to achieve if there are less functions to integrate (Gallman and Belverde, 2011). With the current corporate structure and decision levels such integration seems hard to achieve due to the number of partners. Integration is therefore not assumed a priority in the corporation which could explain the low ranking by the case company. Strategic fit and integration along the supply chain are fundamental for creating and sustaining a competitive advantage as this creates a holistic company entity which is difficult for competitors to imitate.

All the variables within the driver strategy have a significant impact on the supply chain as these together create the environment where other decisions will need to perform (Schmidt and Wilhelm, 2000). Therefore all the variables in the supply chain driver can be considered strategic decisions. Hence strategy can be considered a fundamental supply chain driver. Notably the case company ranked the importance of the driver strategy as number seven out of eight total supply chain drivers. It is evident that the corporation approves all major decisions thus influencing the case company’s direction. This might be an explanation to the case company’s low ranking of the importance of strategy as a supply chain driver as the case company does not solely determines its own strategic direction. The strategy variables are integrated in the decisions of the corporation and therefore have significant strategic importance as the corporation determines the competitive environment for both segments and brands under it. Distribution and warehousing decisions need to be guided and aligned to an overall supply chain strategy.

6.1.2 Product

The case company classified the variables within the driver product as almost equally important which could be a result of the close interrelationships between the variables. The variable product characteristics determine demand predictability and require different supply chain planning depending on the product being either innovative or functional. Product characteristics are closely linked to the variable product life cycle. Different product life cycles require different product strategies that affect the supply chain planning, for example a
product with a short life cycle might need to be pushed into the market due to the risk of obsolescence. *Product volume* is also closely connected to the choice of different supply chains where a high or low volume corresponds to a lean or agile supply chain, see figure 2.11.1, comparing of supply chain characteristics. Companies offering both innovative and functional products should therefore use a combination of supply chains. At the case company the base layers and layer two can be classified as functional products with stable demand and longer life cycles whereas layer three products are more innovative with unpredictable demand and shorter life cycles. However, at present the case company does not differentiate its product supply chains. The base layers are produced in large volumes which can provide economies of scale thus increasing profit margins. This makes base layers one of the most profitable products for the company. According to figure 2.11.1, high profit margins are matched with an agile supply chain whereas long product life cycles and high volumes are matched with a lean supply chain. It can therefore be suggested that a legile supply chain, combining agile and lean elements, is suitable for handling the base layers and layer two. Profit margins for the innovative products are also high, however, product life cycles can be considerably shorter making these products suitable for an agile supply chain. It is therefore suggested for the case company to use an agile supply chain for its layer three products. It is important to understand how product strategies influence the supply chain network design. A supply chain strategy should be aligned with other goals at the strategic levels (Stavrulaki and Davis, 2010). Product variety and characteristics, product volume and product life cycle can be considered strategic decisions as these variables have great influence over the supply chain strategy which in turn is important for both tactical and operational strategies.

The supply chain driver product was ranked as number six out of eight by the case company, indicating that the case company does not regard product as an important element in supply chain decisions. The case company is using the same delivery network for all products signalling that there could be a lack of acknowledging how different types of products require different supply chains which will have impact on distribution and warehousing planning. The low ranking of the supply chain driver could be due a lack of appreciation of the products importance in making supply chain design decisions.

**6.1.3 Service/Quality**

The variables *reliability* and *delivery performance* have received the highest ranking by the case company within the driver service/quality. In the textile and apparel industry there is a tendency of saturation of companies in the market. Consequently this forces companies to focus on delivery quality in order to stay
competitive and maintain customers which could explain the case company’s high ranking of the variables. It is important to understand the underlying decisions made at the other decision levels affecting reliability and delivery performance. Reliability and delivery performance are more concerned with adherence to developed schedules and can therefore be considered operational decisions.

*Responsiveness* and *flexibility* received the lowest ranking in the supply chain driver. Reliability and delivery performance are operational decisions and methods of measuring service and quality which could explain why these variables received a higher ranking. However, the interviews revealed that all variables in the supply chain driver service/quality are considered important by the case company. Evident from interviews is also that there is a desire to be responsive and as a result the company keeps high inventory levels to secure product availability and remain flexible in case of unforeseen demand. Both agile and agile supply chain strategies, which are recommended for the case company, enhances responsiveness and flexibility which affect the distribution and warehousing network. Since supply chain strategy decisions are made on a strategic level, as discussed under the driver product, the variables responsiveness and flexibility can be viewed as tactical as these are set to achieve the results specified at the higher level.

The case company ranked the supply chain driver service/quality as the most important element in supply chain decisions. This can be explained by the volatile demand and the high amount of products offered in the market which makes the service/quality aspects essential for survival in the textile and apparel industry. It is therefore considered an important driver by the case company when making supply chain design decisions.

6.1.4 Cost

The variable *total logistics and distribution cost* was ranked the highest within the supply chain driver cost. The case company express that the decentralised distribution network has become too costly and therefore require a restructuring or change of warehousing strategies. Total logistics and distribution cost can be used as a measure of the logistics performance including warehouse processes. The total cost is also determined by the chosen supply chain strategy and can be considered a tactical decision as it is a way to measure decisions at the higher level. *Cost of holding inventory* is ranked as the second most important variable. Holding of inventory is expressed as a concern by the case company due to the many distribution centres all holding high inventory levels in order to ensure product availability. The cost of holding inventory is a result of products held as stock and can be viewed as a measure of inventory performance and a support tool
for strategies, therefore making inventory holding cost an operational measure.

*Cost of transportation* is ranked third of the variables in the driver cost. Primary transport cost makes it possible to achieve economies of scale by fewer and larger shipments. The distributors try to consolidate packing and transportation between segments for delivery to the distribution centres. On the other hand, local delivery cost is reduced by a decentralised warehouse network see figure 2.14.2, illustrating how costs changes with number of distribution centres. However, the frequent shipment of products between distributors has resulted in increased total transportation costs for the entire corporation. The increased transportation cost is a problem for the case company but it seems inventory costs are of higher importance when considering making distribution and warehousing decisions. The cost of transportation measures the operational activity of product deliveries and is therefore viewed as a support for operational decisions.

*Cash-to-cash cycle time* measures the time it takes for cost to be turned into profit and is closely linked to the total supply chain lead time. The variable received a low ranking by the case company. Holding inventory increases the cash-to-cash cycle time thereby increasing the risk of losing profit due to product obsolescence. The case company has started to monitor inventory turns and has improved its actions to handle stock which is not selling according to the forecast. This could be an attempt to turn cost into profit and as the company is experiencing improvements in its work it can explain the lower ranking of the variable as other cost related posts are deemed more urgent. Cash-to-cash cycle time could as well be a measure of inventory throughput, increased inventory turnover at warehouses leads to a shorter cash-to-cash cycle time. Cash-to-cash cycle time assess how long capital is tied up in the supply chain and is an important measure for both strategic and operational strategies. It does not only cover logistics but includes several functional levels in the company making it a tactical decision.

*Cost of facility* has received the lowest ranking in the supply chain driver. Total cost of facilities will change according to the number of facilities in the network, see figure 2.14.2. At present, the sport and leisure segment in the corporation holds one facility in Sweden which could explain the low ranking of the variable. Considering a restructuring of the distribution network it is unknown which distribution centres that would remain in use and which centres that would be phased out. However if a decision was made to manage the distribution centres centrally it would lead to an overall decrease in cost of facility. However, potential consolidation of stock to fewer distribution centres would increase the need for more labour at these centres, leading to increased cost of facilities. The benefits of a restructuring of the distribution network could out weight the...
possible cost increases of facilities since a reduction of distribution centres could lead to cost savings also in other elements of the total logistics cost see figure 2.14.3, illustrating how cost changes by a reduction of distribution centres. This could explain the low ranking of the variable. The cost of facility is dependent on whether the warehousing function is centralised or decentralised, and changes with the number of depots in the network. It has therefore been classified a tactical decision. Centralised and decentralised strategies are closely linked to total logistics and distribution cost and responsiveness variables which are categorised as tactical. There are however operational elements to cost of facility, for example labour cost.

Cost as a supply chain driver has been ranked as the second most important driver by the case company when considering making supply chain design decisions. Profitability is an important overall goal with the supply chain (Chopra and Meindl, 2013) and the case company’s current distribution network is considered costly and inefficient. Financial issues and costs are recognised as important factors influencing a restructuring decision (Ballou, 1995) which corresponds to the case company’s objectives. When profiling and planning for a new distribution and warehouse structure costs are at the lowest. Therefore it is important to allow this phase to take time to make sound decisions in order to decrease unnecessary later investments.

6.1.5 Macroeconomic factors

Macroeconomic factors as a supply chain driver received the lowest ranking by the case company. The reason for this could be that the internal distributors are already operating on stable Western European markets which generally have good infrastructure and custom agreements. Macroeconomic factors are important considering the logistics performance as the geographical location of the facility will pose certain risks and affect constraints in the distribution network. Macroeconomic factors can still have an impact on the distribution network once the location of facility is decided therefore continuous monitoring of the development in the chosen regions is important. The supply chain driver macroeconomic factors is classified as strategic as it determines the environment where the supply chain will perform (Schmidt and Wilhelm, 2000) and as it affects the effectiveness and costs of the distribution and warehouse network.

6.1.6 Time

*Delivery lead time* has been classified as the most important variable followed by *lead time/cycle time* and lastly *value adding activities*. Delivery lead time is closely linked to the variable delivery performance within the service/quality driver and both variables serves as service determinants often mentioned in
regards to customer value. These two variables have been ranked as most important in the respective supply chain drivers which indicate the importance of customer value for the case company. Delivery lead time is dependent on whether the distribution network is centralised or decentralised. A centralised distribution network will give longer delivery lead times, from distribution centre to customers, compared to a decentralised network. Delivery lead time is part of the variable lead time/cycle time which represents the total supply chain lead time. According to the case company’s ranking the delivery lead time is more important than the total lead time/cycle time. A reason why lead time/cycle time may have received a lower ranking could be that the production process make up the majority of the total lead time and in addition the longer time of transportation from production in Asia also contributes to the total lead time. The case company has however some production in Europe which shortens the time of inbound transportation. The time from distribution centre to customer, so called delivery lead time, is shorter compared to production and lead times of inbound transportation. The higher ranking of delivery lead time could thus highlight customer value when considering making distribution and warehousing decisions. The case company describes an increased demand by customers to delay ordering but with an expected unchanged time of delivery thus putting pressure on the lead time/cycle time. Lead time/cycle time is concerned with the material flows through the whole supply chain making it a tactical decision. Delivery lead time on the other hand is determined by decisions made on higher levels making it operational.

The variable value adding activities can be used to examine the supply chain and to find out where there is potential for optimisation for example where time can be compromised to speed up flow. The variable is important when restructuring the distribution and warehousing function as mapping of value adding activities in the supply chain will indicate where changes are required. It is uncertain if the case company has thought of mapping its supply chain to find activities that could improve value and thereby increase competitive advantage. The variable value adding activities examines the allocation of resources and material flows and is therefore a tactical decision.

Time as a supply chain driver has been ranked as fourth most important in supply chain decisions. The textile and apparel industry is characterised by volatility, low predictability, short product life cycles (Bruce et al., 2004) which has resulted in time being important for the competitive advantage as well as a way to lower risks. Service/quality was ranked as the most important driver and is closely associated with the time aspect. The case company products are suitable for both an agile and leagile supply chain, as discussed under chapter 6.1.2 product, and
for achieving the responsiveness required for these types of supply chains short lead times is a prerequisite.

### 6.1.7 Distribution

The *product/stock availability* variable has received the highest ranking in the supply chain driver distribution. Product/stock availability has become a problem in the current distribution set up partly due to inaccurate forecasts. Currently each distributor is responsible for its own forecasting, budget and sales. As a result the products available at each distribution centre are intended for the specific markets that it serves. It therefore becomes a problem when distributors want to purchase products internally as it affects the estimated product availability at the concerned distributor. The case company describes this as a problem and hope that a restructuring of the distribution and warehousing network and shared available stock will create common objectives and increased collaboration. Keeping 100 percent safety stock is not cost effective but at present customers expect all products to be available at all times. The case company express a desire to always keep high selling products available but products with lower demand do not necessarily have to continually be available at every distribution centre. Product/stock availability is an important variable balancing level of customer service and cost. The decision in this trade off is therefore considered tactical in line with the reasoning regarding the variables responsiveness and total logistics and distribution cost.

*Capacity utilisation of facility* was ranked as the second most important variable in the driver. Since the sport and leisure segment owns the Swedish warehouse the cost implications of not fully utilising the space available is understood. Capacity utilization at the internal distributors varies with some outgrowing their warehouses and some experiencing over capacity. A restructuring of the internal distribution and warehousing function could lead to a possible improvement and increased control over capacity utilisation if kept in-house. Capacity utilisation of facility is categorised as a tactical since capacity flexibility is considered a tactical level decision (Gunasekaran et al., 2004).

The variables receiving the lowest ranking within the driver distribution are *role of the facility, average inventory and location of facility*. At present the distribution strategy is decentralised with distribution centres on most markets, resulting in almost all products being stored at all distribution centres. The current role of the facility is a traditional warehouse used primarily for storage. According to figure 2.9.2, presenting how different service levels should be managed, products with different sales volumes and profit contribution may require different service levels. A decentralised structure is suitable for products with high volume
and high profit contribution to ensure high availability close to the customer. This structure is currently used for all the case company’s products. A change toward a more centralised structure would be suitable for low volume high profit products. This type of products should be held further upstream in the supply chain in order to reduce inventory investments. Consolidating warehouses is a strategy to minimise total inventory levels and allow for better asset utilisation at the fewer warehouses in use. The same benefits can be achieved with a decentralised structure however this requires a central coordinating function within the organisation and an integrated information system. The case company has an average inventory turnover of 2, 4 at the Swedish warehouse and a preferred delivery time of one day which is according figure 2.9.1, presenting variables indicating whether to decentralise or centralise the warehousing function, corresponding to a centralised structure.

A company must decide how the products should reach the customer as this has a significant impact on other supply chain decisions. The variables role of the facility and location of the facility are important determinants on how this is to be achieved. The variables serve as a foundation for subsequent distribution and warehousing decisions and can therefore be considered on a strategic decision level. Since not all distribution centres are designed to hold inventory the variable average inventory follows the decisions for the variables product/stock availability and capacity utilisation thus making it tactical.

The supply chain driver distribution was ranked the third most important driver when making supply chain design decisions. The design of the distribution network and its operational performance can lead to competitive advantages in the market leading to profitability and success for a business. Distribution is integrated with other supply chain drivers and can be viewed as a service to these as planning in other areas might change the need of the distribution network (Frazelle, 2002). At the same time the distribution function is important as it determines how the product reaches the market. As mentioned regarding the supply chain driver time, in chapter 6.1.6, the textile and apparel industry is highly dependent on on-time deliveries and flexibility in the distribution network.

6.1.8 Information
The variables information efficiency and information infrastructure are closely linked. Information efficiency received the highest ranking by the case company whereas information infrastructure the lowest. However, information efficiency is hard to achieve without sufficient information infrastructure. Relationships are a contributing factor to the success of supply chain strategies (Monczka and Morgan, 2003) and to optimise efficiency it seems necessary to integrate
information between actors in the supply chain. The more information being shared the easier it is to make quick and correct decisions. The case company has implemented an infrastructure with the use of an ERP system and additional purchasing system. However the current lack of information efficiency could be the reason for the high ranking of the variable since the case company is experiencing the drawbacks of an inefficient information flow. The corporation’s purchasing system is not fully utilised by the internal distributors. The external distributors do not have access to the system as they are not part of the corporation. In order to increase information efficiency between internal distributors a more elaborate use of the purchasing system would be advisable. This could help to eliminate the time consuming communication and administration concerning internal distributor’s product availability and order entries. Information infrastructure should be tailored to meet the needs resulting from decision made on the strategic and tactical levels as well as integrate operational processes. It is therefore considered a tactical decision. Information efficiency is a result of how the information infrastructure is implemented and used. Hence, the variable is classified as an operational decision.

The variables forecast accuracy and demand information received second and third ranking within the supply chain driver. Information infrastructure enhances the flow and visibility of demand information. This is evident as the case company is working on improving the forecasts made by the distributors which could be enabled by better use of current information systems. Better demand information simplifies the forecasting process leading to increased forecasting accuracy. Receiving timely information regarding demand also enables a company to make flexible decisions. However, real time information regarding demand also reduces the need for forecasts in the supply chain (Christopher et al., 2004). Information efficiency is also a result of forecast accuracy and demand information making the latter two tactical decisions.

Information as a supply chain driver was ranked fifth out of the eight drivers. Unstable demand in the textile and apparel industry makes timely and accurate information beneficial for quick responses in the supply chain. A high level of information is an enabler and support for all decision levels and the information system should accommodate the needs between functions within an organisation. Therefore strategic use of information has effect on the supply chain and warehousing performance.
6.2 Development of the Decision Support System

In order to make strategic warehousing decisions it is necessary to understand the role warehousing play in the supply chain as a whole. A warehousing decision cannot be made in isolation as it is affected by decisions made within other supply chain drivers. Warehousing can be considered a service to other logistic areas and should reflect the needs of these (Frazelle, 2002), see figure 2.6.1, warehousing presented in the logistics management framework. This is also highlighted in previous analysis regarding the decision levels of the variables where the strategic decisions are prerequisites for the supply chain design. The decisions made on the strategic level creates the environment and constraints for decisions made on the subsequent levels indicating the importance of strategic warehousing decisions. Tactical decisions can be seen as determinants of how a company competes whereas the operational decision level serves as a measure of how successful the strategic and tactical decisions are. The different decision levels serve as a support highlighting which decisions need to be considered prior to others. However all decisions at the respective levels need to be aligned. Based on previous analysis in chapter 6.1, regarding the variables decision levels, a Decision Support System is developed, see table 6.2.1. The Decision Support System serves as a guide for which supply chain drivers and variables that strategically affect warehousing decisions. The supply chain drivers represent important supply chain elements when making supply chain design decisions. The importance of the drivers is determined by under which decision level the respective variables are placed.

The variables serve as indicators to be specifically considered when making distribution and warehousing decisions. Studying logistic activities other than distribution and warehousing may have resulted in another set of variables which might have corresponded to different decision levels. However when considering distribution and warehousing decisions and the specific variables identified for this logistic activity, the different decision levels are matched with variables according to the developed Decision Support System in table 6.2.1. The supply chain drivers strategy, product, macroeconomic factors and distribution are of higher importance when considering making supply chain design decisions as these have variables considered strategic. The remaining four supply chain drivers are important but decisions made based on these variables are not considered strategic in nature. The operational decision level can be used to measure the logistics performance. At this level distribution and warehousing inefficiencies can be discovered. Problems at the operational level need to be brought to the higher decision levels to be investigated and solved. The decisions made at the strategic level are transferred to the lower decision levels affecting the tactical and
operational performance. Hence the decision process is two-way (Nollet et al., 2005).

The Decision Support System integrates supply chain drivers, warehousing variables and decision levels. The framework maps strengths and weaknesses with current supply chain and distribution practices thereby finding the requirements needed for the optimal warehousing structure. Once the optimal warehouse structure is implemented the distribution network will enable for the best customer service practices and serve as an effective support for other logistic areas. The Decision Support System facilitates decisions regarding warehousing and simplifies the process of moving from the strategy employed to the best practice strategy thereby increasing customer satisfaction and achieving a competitive advantage.

<table>
<thead>
<tr>
<th>Decision Levels</th>
<th>Strategic</th>
<th>Tactical</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drivers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td>Supply chain control</td>
<td>Cost of facility</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Understanding customer need</td>
<td>Cost of holding inventory</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Company competitive strategy</td>
<td>Cash-to-cash cycle time</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Strategic fit</td>
<td>Delivery performance</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Integration along the supply chain</td>
<td>Product volume</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Product</td>
<td>Product variety and characteristics</td>
<td>Product volume</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Product life cycle</td>
<td>Product volume</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Service/quality</td>
<td>Responsiveness</td>
<td>Flexibility</td>
<td>Reliability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Delivery performance</td>
</tr>
<tr>
<td>Cost</td>
<td>Total logistics and distribution cost</td>
<td>Cost of facility</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost of holding inventory</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cash-to-cash cycle time</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Macroeconomic</td>
<td>Macroeconomic factors</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>factors</td>
<td></td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Time</td>
<td>Lead time/cycle time</td>
<td>Delivery lead time</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Value adding activities</td>
<td>Delivery lead time</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Distribution</td>
<td>Role of the facility</td>
<td>Average inventory</td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Location of the facility</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Capacity utilisation of facility</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Product stock availability</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td>Information</td>
<td>Forecast accuracy</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Demand information</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Information infrastructure</td>
<td></td>
<td>Cost of transportation</td>
</tr>
<tr>
<td></td>
<td>Information efficiency</td>
<td></td>
<td>Cost of transportation</td>
</tr>
</tbody>
</table>

Table 6.2.1. Decision Support System.

6.3 Application of the Decision Support System

The Decision Support System has been applied to the case company as it is considering changes in its current distribution and warehousing network. In line with the Decision Support System the strategic recommendations are of utmost importance as these determine subsequent decisions. Therefore focus has been on
identifying strategic areas which can be improved. However, tactical areas for improvement have also been detected and a few such recommendations will also be analysed. The recommendations found are important for the case company to consider regarding a redesign of its distribution and warehousing network.

The respondents express that there is no overall warehousing strategy for the case company however, the thesis research show that distribution and warehousing decisions need to be guided by an overall supply chain strategy. At present it is the corporation that influences the set up of the supply chain and distribution network with requirements of quick deliveries to customers and high product availability. The operational variables cost of holding inventory and cost of transportation are indicating problems and inefficiencies in the case company’s distribution and warehousing network. These problems are brought to the business unit level however the problems derive from decisions made at the higher corporate level. The corporation and the case company both sell through business-to-business but the case company’s main sales are through retailers. It would therefore be beneficial for the case company to create a distribution and warehousing strategy separate from the corporation accommodating the different needs of the retailing customers. In order to achieve this, the case company alternatively the sports segment, would need more independence within the corporation and given the chance to develop a strategy that entirely fits the competitive environment.

The distribution and warehousing structure currently employed in the case company is agile to the degree of the internal distributors being almost entirely independent. The distribution and warehousing structure in an agile supply chain is decentralised, with many distribution centres close to markets, as this enables higher responsiveness to customer needs. The strategy currently employed is consistent with the textile and apparel industry in general were the unpredictable demand set requirements for agile supply chains or supply chains with agile elements. However, the supply chain strategy to use is depending not only on customer demand but also on product characteristics. As previously discussed, in chapter 6.1.2, the case company should use an agile strategy for its layer three products and a leagile strategy for its base layers and layer two products. In a leagile supply chain strategy products can be stored centrally and therefore a centrally managed distribution centre may be suitable for these products whereas an agile supply chain strategy product should be held in a decentralised distribution structure. One suggestion regarding a redesign of the case company’s distribution network would therefore be to continue using a decentralised warehousing structure but upgrade one or a few warehouses to serve a more central role. A second option for the case company regarding redesigning of its
warehouse network would be to only manage distribution centrally from one or a few warehouses. This would increase control over product inventory levels as is desired by the case company and enable for closer collaboration between internal distributors. As well, the current inventory turnover at the case company and preferred short delivery times of a few days corresponds to a centralised warehousing structure, according to figure 2.9.1. A decentralised network would according to the figure require an inventory turnover of 16 or higher compared to the current 2, 4 at the Swedish distribution centre.

Regardless of which distribution network strategy being used different product groups can be managed by the use of an ABC categorisation. A-products with high volume high profit contribution are considered of higher importance and should always be kept on stock and available upon request. A C-product on the other hand with lower profit contribution and lower sales volumes is not as important to always have available and can be delivered within a longer time period. The segment of corporate promo in the corporation is already employing such a strategy which therefore easily could be transferred also to the sport and leisure segment thereby incorporating the case company.

Since retailers select only a smaller part of the total collection the case company is considering opening an online store in order to make the whole collection available to customers. Online retailing would perhaps make one central warehouse more accommodating as stocking all products at one location would increase control over inventory levels. A centralised distribution and warehousing structure leads to somewhat longer lead times through longer outbound deliveries. However, by encouraging and educating the distributors in monitoring the inventory levels better planning of replenishment orders can be achieved and thus the longer lead times will have less impact.

Inventory levels are seen as costly and the transportations of goods between internal distributors as inefficient and time consuming to the case company. To solve these problems there is a third option for improving the warehousing network for the case company which is to keep current decentralised structure but implement an elaborate centrally coordinated supply chain function. Central coordination of a distribution system can reduce administrative and transportation costs as well as reduce lead times in the distribution network (Christopher, 2005), as explained in chapter 2.9, a centrally coordinated warehouse function would create common objectives and enable for closer collaboration. Depending on the chosen distribution and warehousing strategy the information infrastructure need to be aligned and supportive to enable improved and timely communication. Current information infrastructure should be utilised more effectively to enable a
more efficient information flow. The information infrastructure should be
customised depending on the decisions made on the strategic level, see the
Decision Support System in table 6.2.1.

Both the supply chain drivers cost and service/quality have received the highest
ranking by the case company. However, this is recognised as a well known trade-
off in supply chain management (Baker, 2006). It is not possible to offer the
highest service at a very low cost. Customers do not demand the highest service in
every situation (Chopra, 2001), the key is to define the desired service
requirement for the company’s particular customer and manage costs accordingly.
The case company ranked the supply chain driver service/quality as of highest
importance when making supply chain design decision indicating that service is
somewhat more important than cost for making supply chain design decisions.
Implementing different supply chains depending on product characteristics
requires different focus on the distribution and warehousing processes. The agile
supply chain requires more responsiveness and flexibility compared to the leagile
supply chain which can be more cost efficient.

As the textile and apparel industry is characterised by low profit margins there is
always a desire to lower costs which has led to outsourcing to low labour cost
countries for example in Asia. However, the increased lead times of such a
decision can pose the question whether production in Europe is an alternative
choice. Although labour costs in Europe are higher, the shorter lead times would
lead to reduced cost of transportation, increased responsiveness and supply chain
control ultimately leading to the same costs impact as outsourced production in
Asia. Since delivery quality is considered important in the textile and apparel
industry shortening of lead times would be beneficial as it increases control over
deliveries.

By implementing the recommendations found from applying the Decision Support
System the case company will achieve alignment of its supply chain and
warehousing strategies. The business to business strategy would stay aligned with
the corporate strategy whereas new strategies concerning the retailing sales
channel would be formed at the business unit level or sport and leisure segment. A
set level of where decisions are formed and integration of strategies would lead to
the distribution network becoming better designed for meeting requirements from
other logistic areas. A well designed distribution and warehouse network together
with differentiated supply chain strategies would decrease total logistics and
distribution costs for the case company. Product availability would still be
maintained but better managed with a balance of required responsiveness and
cost. A changed distribution structure with integrated information systems and
warehousing practices would enhance collaboration between the case company and the distributors. The common practices would enable increased focus on creating value for the customers.
7. Conclusion

This chapter presents the findings in this thesis. First, the research question, how should decisions regarding strategic warehousing be made, is answered. Secondly, the benefits of applying the Decision Support System prior to a change or restructuring of the warehousing network is presented. Finally, the results from applying the Decision Support System to the case company are summarised and it is explained how the case company by following the recommendations suggested will improve its warehousing performance.

7.1 Executive summary of the research

Supply chain management has not been fully extended into warehouse network design and information regarding on which level warehousing decisions are formed was limited. The Decision Support System, table 6.2.1, bridges these gaps by identifying eight important drivers for making supply chain design decisions each including variables focusing on making distribution and warehousing decisions. Since the distribution and warehousing network is incorporated in the supply chain warehousing decisions cannot be made in isolation but is affected by decisions made within other logistic activities. There are therefore variables in the Decision Support System which are related to the supply chain as a whole and others more specifically related to distribution and warehousing decisions. The interplay of these decisions extends the literature on supply chain management into warehousing. The case company contributed with in-depth knowledge of what is valued when making changes to the distribution and warehousing network. It helped when categorising the variables with corresponding decision level highlighting if the decisions are strategic, tactical or operational. Evident in the Decision Support System is that warehousing decisions spans over all decision levels.

The Decision Support System helps to develop an understanding of which areas are essential for textile and apparel firms considering making changes in its distribution network and how strategic warehousing decisions can be made. To clearly answer the research question decisions regarding strategic warehousing can be made by studying the variables placed at the strategic decision level in the Decision Support System presented in table 6.2.1. Since warehousing decisions in the distribution network will influence a company for a long time it is important to consider needs from all strategy levels prior to a change or restructure of the distribution network. By using the Decision Support System it is easy to identify the warehousing decisions that are strategic and the variables to be considered.
prior to others when evaluating or making changes in the distribution and warehousing network. The strategic variables form the competitive strategy of a company and create the environment from where other decisions will need to perform. The Decision Support System serves as a framework for managers in identifying critical supply chain areas that will impact the distribution and warehousing network.

Strategic warehousing decisions can lead to a well designed distribution and warehousing network. Once the optimal warehouse structure is implemented the distribution network will enable for best service practices to the customers and serve as an effective support for other logistic areas. The Decision Support System facilitates decisions regarding warehousing and simplifies the process of moving from the strategy employed to the best practice strategy thereby delivering excellent customer service leading to achievement of a competitive advantage.

**7.2 Recommendations for the case company**

Inadequate practices and technology can keep companies from properly serving the customer and accordingly the empirical study revealed problems and complexities in the case company's distribution and warehousing network. In order to find possible future improvements to current practices at the case company the Decision Support System was applied. Several possible improvements were found which are evident in the strategic and tactical recommendations for the case company, see table 7.2.1. The different issues indentified from the empirical study have been structured in column two according to supply chain driver and corresponding decision level in column one. The effects of found issues have been thoroughly analysed in column three. To overcome the issues presented a number of recommendations are presented in column four, providing the case company with a number of practical solutions to consider before restructuring current distribution and warehousing network.
A well designed distribution and warehouse network together with differentiated supply chain strategies would decrease total logistics and distribution costs for the case company. Product availability would still be maintained but better managed with a balance of required responsiveness and cost. A changed distribution structure with integrated information systems and warehousing practices would enhance collaboration between the case company and the distributors. The integration of practices would enable shared focus on creating value for the customers.
8. Future Research

This chapter provides suggestions for future research on the subject of warehousing decision making. Ways to build on the developed Decision Support System is given.

The effects of the recommended solutions could be examined by a follow up to evaluate the outcome of the case company’s distribution and warehouse restructure. The outcome from the follow up could be used to examine the Decision Support System. Further applying the Decision Support System on other companies, evaluating or considering making changes in the distribution and warehousing network would examine its generalisability. A follow up at the case company and studying of other companies could therefore identify opportunities to build on the existing framework.
List of References


vi
Appendix A - Interview Guide

- Berätta om din roll på företaget.
  - Vad heter du?
  - Vad har du för position på företaget?
  - Vad är ditt ansvarsområde?
  - Hur länge har du arbetat på företaget?

Nuvarande situation

- Hur ser logistiska flöden ut idag?
  - Produktflödet?
  - Informationsflödet?
  - Flödet av pengar?

- Hur arbetar ni med distributörer idag?
  - Hur ser ägarförhållandet ut?
  - Hur ser relationen ut till distributörerna och även relationen mellan dem?
  - Vilka produkter håller distributörerna?
  - Vad har de för lokaler?
  - Hur utnyttjar de sin kapacitet?

Strategi

- Vad är er nuvarande företagsstrategi?
  - För hela koncernen?
  - För ert varumärke?

- Vad är er marknadsstrategi?
  - Vilka är era nuvarande marknader?
  - Har ni några krav på marknaderna?
  - Planerar ni att expandera?

- Hur ser er beslutsprocess ut?
  - Var tas beslut i koncernen?

- Vad är er nuvarande lagerstrategi?
  - Är lagerstrategin lika för alla produkter?
Konkurrens

- Vem är er kund?
  - Vad har er kund för behov?
- Hur ser er konkurrens på marknaden ut?
  - Förekommer benchmarking?
  - Vad har ni för styrkor/ svagheter jämfört med era konkurrenter?
  - Vad karaktäriserar sport branschen idag?

Problematik

- Ser ni några problem med er nuvarande situation?
- Vad föranledde tanken om att förändra er lagerstruktur?

Vad hoppas ni ska förbättras

- Vilka fördelar respektive nackdelar ser ni med centralisering av lager?
- Vad hoppas ni ska förbättras med förändrad lagerstruktur?
  - Supply chain drivers; strategy, product, service/quality, cost, time, macroeconomic factors, distribution, information.
## Survey

The purpose of this survey is to receive data input from you as our case company and to find out which variables you consider important regarding warehousing decisions.

Please rank the eight groups according to your opinions of their relative importance considering making supply chain design decisions. 1 being the most important, 2 second most important and so on.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables – for information please see attached comments in the upper right corner</th>
<th>Please rank the variables according to your opinion of their relative importance within each group, considering distribution and warehousing decisions. 1 being the</th>
<th>Do you miss any variable? If so, please add below.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>Supply chain control &lt;write here&gt;</td>
<td>&lt;write here&gt;</td>
<td>&lt;write here&gt;</td>
</tr>
<tr>
<td></td>
<td>Understanding customer needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Company competitive strategy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strategic fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integration along the supply chain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>Product variety and characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product life cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service / Quality</td>
<td>Responsiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delivery performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Total logistics and distribution cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost of facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost of holding inventory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost of transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cash-to-cash cycle time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroeconomic factors</td>
<td>Macroeconomic factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Lead-time / Cycle time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delivery lead time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value-adding activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td>Role of the facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location of facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity utilization of facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average inventory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product/ stock availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>Forecast accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Demand Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information Infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information Efficiency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C – Explanation of the Variables

Strategy

- **Supply chain control**
  
  *Trying to manage supply chain risk and control through warehousing decisions, for example by not outsourcing activities.*

- **Understanding customer need**
  
  *Realising the drivers that make the customer acquire a product or service and tailor the supply chain to meet the customer’s needs.*

- **Company competitive strategy**
  
  *Supply chain decisions are critical for achieving and maintaining a competitive advantage as competition through supply chains are increasing.*

- **Strategic fit**
  
  *The alignment of strategies within a company and between supply chain actors. Matching the aligned strategies with customer needs create a competitive advantage which would not be achieved by each actor in isolation.*

- **Integration along the supply chain**
  
  *The level of involvement and collaboration between actors in the supply chain is closely linked to its success.*

Product

- **Product variety and characteristics**
  
  *Different products require different supply chain strategies depending on for example being either innovative or functional*

- **Product volume**
  
  *Understanding that depending on volumes produced at a given time some products are more suitable for supply chain processes focusing on economies of scale for example, which affects warehouse decisions and strategy.*

- **Product life cycle**
  
  *Understanding that the evolvement of the product life cycle over time may require continuous evaluation and changes in the supply chain handling.*

Service/ Quality

- **Responsiveness**
  
  *Refers to the ability of a supply chain to meet short lead times, handle a large variety of products, meet service levels and handle supply and demand uncertainties.*
- **Reliability**
  *The right distribution structure can lead to increased reliability through fewer errors in order processing and delivery of the product to the customer.*

- **Flexibility**
  *Warehouse flexibility is the ability to arrange urgent deliveries when required, have flexibility in the frequency of deliveries, respond to special request by the customer and respond to changes in the warehousing capacity.*

- **Delivery performance**
  *The planning and scheduling of deliveries which includes frequency of deliveries and on-time deliveries.*

**Cost**

- **Total logistics and distribution cost**
  *The cost impact of all distribution and warehousing activities which changes with number of distribution centres in use.*

- **Cost of facility**
  *Cost of facilities includes staff, building and building service as well as equipment and information technology. The cost increases with number of facilities in use and is also affected by distribution centre size and efficiency.*

- **Cost of holding inventory**
  *Can be broken down into capital cost of physical stock, service cost with insurance as well as stock management and cost of risks including damages and stock obsolescence.*

- **Cost of transportation**
  *Consists of inbound and outbound transportation costs which vary depending on the location and number of warehouses.*

- **Cash-to-cash cycle time**
  *The time from investing working capital in a product until investments are financed by received payment.*

**Macroeconomic factors**

*The significance of a country’s taxes, tariffs, exchange rates, political situation, infrastructure and competitive climate, and how these impact level of risks, costs and effectiveness in the distribution network.*
Time

- **Lead-time / cycle time**
  
The time between receipt of an order until delivery of finished product to customer.

- **Delivery lead-time**
  
The time of delivery from distribution centre to customer is determined by the warehouse location.

- **Value adding activities**
  
Mapping of time consuming logistical activities that add more cost than value. Reduction of non value adding activities will lead to improvements and increased efficiency in the supply chain.

Distribution

- **Role of the facility**
  
Clearly defining the activities to be performed in the facility to support the distribution strategy.

- **Location of facility**
  
The decision of where to locate facilities will affect the cost-service trade off by centralisation or decentralisation of warehouses.

- **Capacity utilisation of facility**
  
The degree to which the capacity of a facility is utilised and optimised for improved efficiency and cost effectiveness in a warehouse.

- **Average inventory**
  
Amount of inventory at a facility at a given time and the frequency of stock replenishment.

- **Product/stock availability**
  
The ability to fill an order from available inventory at warehouses.

Information

- **Forecast accuracy**
  
Information enables for a more accurate forecasts which can be used for managing seasonal factors and reducing inventory levels as well as for avoiding stock outs and minimising obsolete inventory.

- **Demand information**
  
To what degree real time demand information affect supply of goods thereby enabling for better warehousing planning.

- **Information infrastructure**
  
The degree to which an information system is integrated between functions in a firm, as well as between partners in the supply chain, for increased efficiency and transparency.
Information efficiency

How well and timely information move across the supply chain and if a decision can be made in real time or with a time delay.