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Definition and analysis of Never Out Of Stock (NOOS) products at Ellos AB

Master of Science Thesis in the Master Program Supply Chain Management

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ABSTRACT

Ellos AB is a leading Scandinavian based apparel and home textile retailer founded in 1947. The company as a part of their reorganization efforts is emphasizing in adopting effecting strategies for increasing their efficiency by effectively using the available resources. Never Out Of Stock (NOOS) products sold by the company contributes to a major share of the incomes and therefore an effective supply chain strategy would help the company achieve the best results for their efforts.

The thesis is done on behalf of Ellos AB. This purpose is to clearly define the NOOS products at Ellos AB. Further on, an analysis on the defined NOOS product segment would be done in order select a suitable supply chain strategy for the segment which would help increase the effectiveness of the Ellos AB supply chain.

The author conclude that the definition of the NOOS products can be done through product segmentation. Also, the NOOS supply chain can be optimized by adopting a material planning system of Joint Economic Lot sizing Problem (JELP) for better order planning. This would then be complimented by a Re-Order Point (ROP) replenishment system to reduce the tied up capital and reduce the risk of shortages.

Keywords: NOOS, Product segmentation, JELP, Re-Order point system

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Kadalikkattil Sajeevan

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Introduction

This thesis deals with the Never Out Of Stock (NOOS) products at Ellos AB which is a leading Scandinavian apparel and home textile online retailer headquartered in Borås, Sweden. The thesis is an effort to define and analyze NOOS products at Ellos AB. This is being done with an aim of reducing the tied up capital associated with the NOOS products through implementing a suitable order, planning and control system to manage the material flow with a better efficiency. This chapter defines the key concepts and provides a historical perspective of textile industry and its evolutions through globalization. Next follows a brief description of the focal company and the reasons for proposing a thesis work for improving their NOOS products material flow. Lastly, the objective of the study is explained which results in the problem statement and purpose of the thesis.

Background

Ellos AB is one of Scandinavia's leading apparel and home textile online retailer. As a part of the reorganization of the company, the management is strategizing to evolve the company from a demand driven organization to a profit driven organization. As a result, various strategical approaches are being employed. Product segmentation of the entire portfolio in order to enable Ellos AB to adapt different supply chain strategies for different segments with varying demand characteristics is one of them. Since, NOOS products contribute to a major revenue share of the company, special attention is being given to this product segment. This thesis work is thus an effort towards defining the NOOS product segment at Ellos AB. This would be then followed by analysis of the present strategies employed for NOOS portfolio. The thesis work would then conclude with recommendations at Ellos AB through which they would be able to optimize their supply chain for NOOS products therefore reducing the overall system inventory and the associated tied up capital.

Limitations

Ellos AB is a large organization with a turnover of over 1.96 Billion SEK annually. Naturally, the size of the product portfolio is very large. Since limited time is available for the thesis work, the NOOS products which would be considered for the further analysis after the product segmentation would be restricted to selected products (products producing high revenue and having varied different characteristics). Also, the number of SKU's under each product type is very high and becomes very hard to analyze owing to the high amount and complexity of historical data available. Thus the analysis work would be done on the product level.

OUTLINE

The outline of this thesis consists of seven main chapters, beginning with the introduction to the thesis topic proceeding to the theoretical framework, the methodology, empirical findings and analysis which would be followed by the recommendations and conclusion. Short explanations of the chapters are as follows:

Introduction – This section is an abstract description of this master thesis. It briefly explains the contents of the thesis along with the aim of the research work. It then explains the significance of the thesis work at Ellos AB.

Theoretical framework - In this section the author develops a theoretical framework on the significance of product segmentations in the textile industry. In addition, theoretical backgrounds on NOOS products in special would be presented, giving precedence to the various order, planning, control process and replenishment order systems which are suitable for NOOS products.

Methodology – The methodology is an indication towards the quality and reliability of the study. A standard method of approach would be explained in this chapter which combines approaches that matches both theory and empirical findings.

Empirical findings – This section describes in possible product segmentation at Ellos AB products. Further on, it also provides the present order, planning and control policies being employed at Ellos AB for the NOOS products. This would include details about the material planning system and the associated replenishment policies being used by the company.

Analysis - This chapter combines the empirical findings with the framework. Primarily, the significance of NOOS products at Ellos AB is evaluated. Then the current planning process of dealing with NOOS products is evaluated followed by the improvement suggestion for an efficient material flow of the NOOS products. This would be done with the findings from the theoretical model built as presented in the theoretical framework. This would then be followed by elaborating on the possible improvements that could be achieved by Ellos AB by implementing the recommended model.

Recommendations – This chapter summarizes the actions recommended by authors to Ellos AB towards dealing with the NOOS products with a suitable supply chain model**.**

Conclusions – The conclusion of this thesis is then comprehensively provided in this section. It also answers the research questions therefore fulfilling the purpose of this thesis.

BACKGROUND

This chapter is a general introduction to the thesis topic. It starts with the general description including globalization, the consequences of globalization on the textile industry. It then provides a brief insight into the company background of Ellos AB followed by the major problems being faced by the company which lead to the proposition of the thesis work. The purpose of the thesis work and the associated research questions are then stated.

GENERAL BACKGROUND

According to Meyer (2007), globalization can be defined as expanded interdependencies and rates of transactions around the world. This has resulted in an expanded economic exchange through global production, commodity chains, flow of technology and 'intellectual property', flow of labors and laborers and most importantly by means of cross-national investment patterns. As mentioned by Tiffany et al (2011), Globalization began as soon as the world started becoming connected in the beginning of human history with the trading beginning when the European explorers began trading on their voyages overseas. This trading was further enhanced by the opening up of the Suez Canal along with new rail routes which decreased the transportation time between Europe and Asia. Post the 1970's, all the three circuits of capital (sales, finance and production) were internationalized more than any other time in history mainly owing to the advent of technological development and liberalization of government trade policies. On analyzing the trends of globalization, Heshmati (2003) inferred that magnitude of globalization has been increasing side by side with increase in available technology and convenience of improved transport. As a result, the mobilization within Europe increased fifty percent throughout Europe. Transporting goods from one country to another has become much easier and cheaper. The freight cost for bulk products has decreased 65-70% since 1950's (Nils Gustav Lundgren, 1996). This decrease in transportation cost triggered the business to garner greater profits by factory relocation, concentrating production in one sector or one location where inequalities in countries exists (Heshmati, 2003). This has resulted in senior managers having an increasing tendency in order to outsource in order to drive costs out of their operations in order to increase sales and production with an aim of maximizing the overall profits. This is a consequence of globalization of the world economy endowed with high technology, skilled labor and other factors of production. At present, most of the profit maximizing companies recognizes outsourcing as an additional approach of reduction in operations cost as well as increasing sales and production. These companies as a result of outsourcing are thus virtually limited to design work, marketing and selling (Elhami, 2003). This increases the firm's competitiveness and ensures high quality and continued success in productivity and market entry. This success can be attributed to the firm's strategy of expanding into emerging capitalist economies where the production factors such as labor, capital, and technology can be obtained and used at the lowest possible cost which ultimately helps in maximizing the profits.

While considering the consequence of globalization on the textile industry, Viswaprakash et al (2012) says that in 1975, the average wage for a textile worker in the US was at an average 10-15 times higher than the wages in countries like Hong Kong, Taiwan and South Korea commonly termed as Newly Industrialized Economies (NIE's). This wage difference was a major attraction for the textile and clothing (T&C) companies from the US and Japan to set up their production in these countries. Moreover, these Asian countries were able to add other benefits like improved quality, flexibility and stylish merchandise. This resulted in an increased imposition of quota by the US and western countries on these traditional T&C companies. In response to this, these companies have in turn shifted their production to the less developed countries (LDC) in Asia including China, Indonesia, Thailand, Pakistan, Srilanka and Vietnam since the 1980's. The arbitrary export restriction was also a contributing factor to this shift. As a consequence of globalization, the global cumulative Foreign Direct Investment (FDI) for the textile, garment and leather industry was estimated at USD 90 Billion, three times the FDI in 1990 (Witkowska, 2011).

China has since then become the largest T&C exporter with other Asian countries like India, Indonesia, Pakistan and Thailand also constituting for a major share in the global T&C market, (Viswaprakash et al, 2012). Also, the quota system which limits the textile and apparel import into the United States and other nations ended for all members of the World Trade Organization (WTO) in 2005. This has resulted in an increase of exports from low wage countries, and China and India in particular growing rapidly dominating over the textile and apparel sectors. These changes brought about by Globalization have altered the competitive dynamics of nations, firms and different industries. According to Gereffi (1999), the key reason for the rise of NIE's in 1970-1980's and China after 1990's as world class exporters was their ability to transform themselves according to the dynamics of the buyer driven commodity chains by supplying a wide range of labor intensive commodities including apparel, footwear, toys, sporting goods etc. These supply chains were able to evolve themselves from mere assembly of imported inputs to a domestically integrated and higher valued added supply chains. However, this increased outsourcing activities resulted in the supply chains having long lead times. This long lead times with slower responses resulted in increase in average inventory at the buyer end leading to higher tied up capital associated with the inventory (Joseph, 2012). This increased tied up capital often effect the company's goal of acquiring the finished good at the lowest possible cost. To achieve the goal of cost effectiveness, supply chain management as a concept has come under the scope and is being enforced with high priority (Lam & Postel, 2006). The same ideology has been employed by Ellos AB in order to provide the customers with high quality goods in line with the market trend without compromising on the cost effectiveness.

According to Quinn (1997), Supply chain management includes all those activities with moving goods from the raw material stage through to the end user. This includes sourcing and procurement, production scheduling, order processing, inventory management, transportation, warehousing and customer services. It also embodies the information systems necessary to monitor all of these systems.

According to Matilla (1999), the success factors of fashion retailing are dependent on four critical factors which affect each other (Figure 1). These could be summarized in four steps with the first factor signifying that it is important for the T&C companies to understand that different products have different demand characteristics. This leads to the second factor which states that it is important to segment the products with similar demand characteristics into own product segments. An example is that of distinguishing between fashion products and basic products. The third factor denotes that the company should understand that the customer lead times for different products might be different. All of these factors leads to the final critical success factor which requires the company to choose the appropriate supply chain strategy based on the demand characteristics and the required lead times.

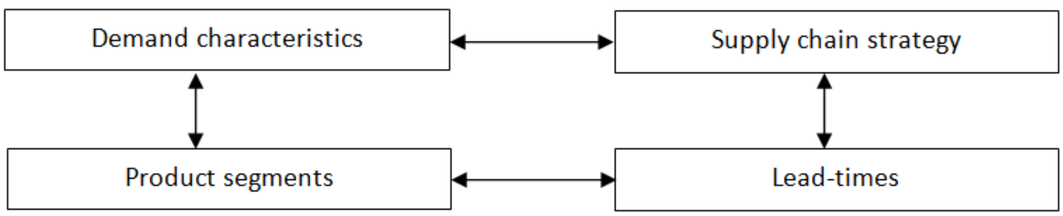

Figure 1: Critical success factors in fashion retailing (Adapted from Mattila,1999)

As mentioned above, it thus becomes significant to classify different products according to their demand characteristics and adopt suitable strategies for different segments.

COMPANY BACKGROUND

Ellos Group is one of Scandinavia's leading home shopping companies with an annual turnover of more than €1.96 billion and 800 employees. Ellos Group is a highly popular E-commerce retailer in Sweden with 95% of the Swedish population recognizing the brand. Ellos Group sells its products both through catalogue and on-line, with 80% of sales happening through the e-shopping platform. The online website has over 900 000 visitors every week with over 2 million active customers with 4.2 million packages being shipped from the warehouse in Borås every year. The Ellos Group consists of Ellos AB and Jotex, and together they form the Nordic region's largest remote shopping marketplace for clothing and textiles. Both Ellos AB and Jotex have a broad product range with Ellos AB providing fashion and home products, and Jotex selling products within home textile and decoration. The Group is headquartered in Borås, Sweden, serving primarily Sweden, Finland, Norway and Denmark. The contribution of each country towards the total sales of Ellos AB is represented in the pie chart below.

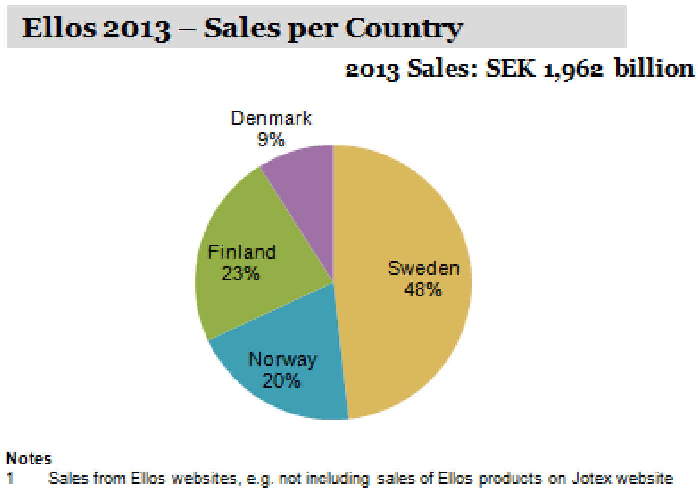

Figure 2: Sales contribution per country

Ellos AB was founded in 1947 by Olle Blomqvist. The Ellos Group is now owned by the Sweden-based venture capital company Nordic Capital fund VII. The company since its inception has gone through major acquisitions and change in organization structure in the last 60 years. The history of Ellos AB since it was founded is described in the figure below.

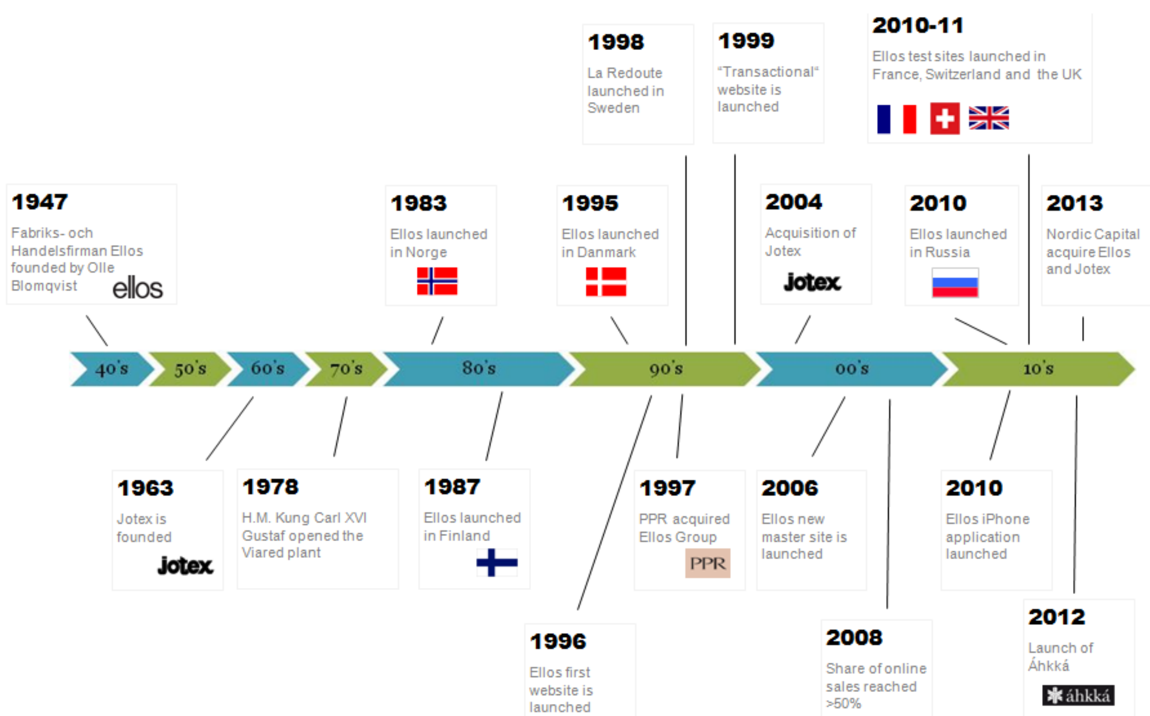

Figure 3: Ellos AB since inception in 1947

Ellos AB mainly sells the products designed by the company through their online website. Apart from that, a variety of external brands which include brands like Puma, Nike, Converse, Reebok etc are also being sold through their online website. At present, the major product launches at

Ellos AB happens based on 4 catalogues with the 60% new products included in the 1st catalogue followed by 20% from catalogue 2 and 30% and 10% respectively from the 3rd and 4th catalogue respectively. Also every financial year is divided into two seasons namely the Spring-Summer season (1st Jan-30th June) and the Autumn-Winter season (1st July-31st Dec). Both the seasons are followed by short tail seasons which are scheduled from 1st July-31st Sept and 1st Jan-28th Feb for the spring-summer season and autumn-winter respectively. The tail seasons are meant to avoid overstock of the products and the unsold products are generally offered to the customers on a discounted price.

At present, the product portfolio of Ellos AB is classified into two, the first one being the general products with a short life cycle of approximately 9 months from inception of their sales. The second category includes the never out of stock products which experiences stable demand through-out the year. The management of inventory of these products at Ellos AB is done through an in-house developed software called ‘Tell Us’. Ellos AB has an extensive and complex supply chain with the design and development of the Ellos AB core collection happening in house. When it comes to sourcing, majority of the manufacturing is outsourced to Asian countries like China, Bangladesh and India. The manufactured products are then shipped to the warehouse in Borås through a combination of sea transport and air freight. Further on, all the Nordic sales are handled and shipped from Borås warehouse with the sales being done through the online website supported by call centers open seven days a week and covering all the Nordic countries.

Currently, Ellos Group is going through a reorganization phase with the new business model emphasizing on the significance of profitability, division of responsibility so as to better position of company in the market and increase its market penetration. On an overall perspective, Ellos Group wants to steer itself from a demand driven organization to a profit oriented organization. These initiatives are expected to help the company increase their sales without any compromise on the service levels as well. Adding on to the strategy is the gradual shift of catalogue application as a sales channel to a marketing channel.

NOOS PRODUCTS

The first step in deciding an effective supply chain strategy is to consider the demand characteristics of a company’s supply (Fisher, 1997). The products sold can be classified majorly into seasonal, fashion and NOOS products. This classification is predominantly based on the demand characteristics, life cycle stage, demand pattern, volume and planning horizon as represented in Table 1, Charu and Chandra (2001).

The NOOS products also known as functional products do not change quickly with time and generally is characterized by a stable and predictable demand with a long life cycle. However this stability invites competition which leads to lower profit margins. However, on the contrary the innovative products have unpredictable demands with product life cycles spanning in terms of months. These products are in fact characterized by short life cycles, greater variety and high margins (Fisher, 1997).

The predictable demand of the functional products makes the market mediation easy as a good match between the supply and the demand can be obtained. Thus the companies can exclusively focus on reducing the physical costs of the functional products in their portfolio (Fisher, 1997).

Table 1: Characterization of products in the apparel and fashion industry (Charu and Sameer, 2001)

	SKU category		
Product characteristics	**Basic**	**Seasonal**	**Fashion**
Product type	Towel	Coat	Sportswear
Life-cycle stage	Maturity	Saturation (very short life cycle)	Saturation (short life cycle)
Demand pattern	Level	High variability	Low variability
Volume	Heavy	Moderate	Moderate
Replenishment lead time	Short	Long	Long
Planning horizon	Long	Short	Short
Cost			
Fixed	Low	Very high	High
Production or purchase	Low	Very high	High
Carrying	High	Very high	High

Problem area

One major characteristics of the modern business management models which sets it apart from the traditional business models is that business entities no longer compete as solely autonomous entities, but rather as supply chains. The management of network has entered the era of internetwork competition wherein supply chain competes against each other rather than brand versus brand of store versus store. Thus in this competitive environment, the success of any single business effectively depends on the management’s ability to integrate the companies intricate network of relationships through supply chain management. This indicates the significance of supply chain members realizing the natural inefficiencies that might develop within and working collectively towards eliminating them so that supply chain as a whole would be able to compete effectively (Saunders et al, 2003).

As a part of a strategic change Ellos AB has been undergoing since 2013, the management was looking into incorporating SCM concepts in their value chain which would help them deal with the efficiencies in their chain. According to sales data, products which were sold for more than three seasons which could be classified as potential NOOS products constituted 47% of the annual turnover. The major problem associated with NOOS products of Ellos AB was that they didn’t have a well-defined NOOS portfolio. This had become the reason for certain products with stable demand either running out of stock or being in overstock as a result of improper planning. Other major concern of Ellos AB was the high inventory cost that was associated with the NOOS products. Even though, the service level remained satisfactory, the incumbent cost due to the high level remained a problem at Ellos AB. This thesis is thus an effort towards defining and analyzing the potential Never Out Of Stock (NOOS) Products at Ellos AB.

Classifying the products according to their demand characteristics and adopting suitable supply chains for different product segments has become a common practice among major global textile chains. Therefore one of the priorities of the company's top management was to analyze the historical data of Ellos AB in order to define NOOS products. Further on, the management was interested in formulating an analysis of demand characteristics, inventory turnaround ratio, average tied up capital of the defined NOOS products which would help them understand the magnitude of inefficiencies in their supply chain. Another major expectation from the thesis was then to provide recommendations on the basis of analysis work on how to deal with the inefficiencies persistent in the Ellos AB supply chain for NOOS products and minimize them for a better managed value chain.

PURPOSE

As stated in problem statement above, the purpose of the thesis work can be stated as follows:

The major purpose of this thesis would be to clearly define products segments at Ellos AB. The newly defined NOOS segment would then be analyzed with the thesis concluding with recommendations to improve the order, planning and control policies for NOOS product segment throughout the Ellos AB supply chain.

The above purpose would thus be fulfilled by the following research questions:

RQ 1: What are the possible product segments for the Ellos AB portfolio?

RQ 2: What are the major benefits of product segmentation and what is its scope for the NOOS product segment?

RQ 3: Which order, planning and control policies are being employed by Ellos AB for their NOOS product segment?

RQ4: What are the major shortcomings of the present order, planning and control policies?

RQ5: What order, planning and control system could be implemented for the NOOS product segment so as to avoid the shortcomings of the present policies?

RQ6: Which replenishment system would best support the selected order, planning system?

RQ7: What would be the added benefits of implementing the recommended replenishment system?

THEORETICAL FRAMEWORK

This chapter presents the theoretical framework for the development of the NOOS definition and analysis of the NOOS segment. The chapter consists of three sections. The first section is a theoretical outlook on the supply chain management in the textile industries and the significance of product segmentation in product portfolio. The second section deals with the order, planning and control process in supply chain proceeding to the third section which deals with inventory management, its significance. Thereon, the various replenishment systems which are popular in the industry are explained briefly.

SUPPLY CHAIN MANAGEMENT IN TEXTILE INDUSTRIES

The significance of supply chain management has changed drastically in the last two decades. Globalization of the textile and clothing supply chain has intensified with many companies choosing to either sourcing from overseas or setting their manufacturing plants in countries with cheaper labor. This has resulted in the textile supply chains becoming very complex, long and often with many parties involved with them. As a result a number of strategies are being applied in the textile and clothing supply chains in order to improve the supply chain management through quick and accurate response. Key to these improvements is improved customer order demand management and a reduction in wasteful activities. This remains significant as well since there are always limited resources available with any enterprise (Margaret et al, 2004).

Taking a firm decision on the order placements can result in two scenarios, one scenario wherein the supply of the materials fall short of the actual demand with the lost opportunity for sales and the unsatisfied customers turning to the competitors. The other scenario would be that the demand falls short of supply resulting in excess inventory which might result in loss due to disposing the excess inventory (Cachon & Terwiesch, 2008). With that said, a company can be said to have a sustainable supply chain strategy if it takes the entire product folios into account. It is significant to have multiple supply chain portfolios for different product folios. This according to Langenberg et al (2012), helped save HP millions of dollars by realigning their product folios into suitable supply chain platforms.

The segmentation of product demands into functional (NOOS) and innovative (fashion) products helps the organization to employ different strategies for different products, namely a responsive supply chain being employed for the innovative products and an efficient supply chain strategy being adapted for the functional products. Both these strategies in turn help the downstream supply chain to reduce the stock levels in retailing industry (Lam & Postel, 2006). The above stated strategies has also been held true by Fisher (1997), who formulated the matrix in Figure 4, so as to determine if the supply chain strategy that has been adapted for the product segment is suitable or not.

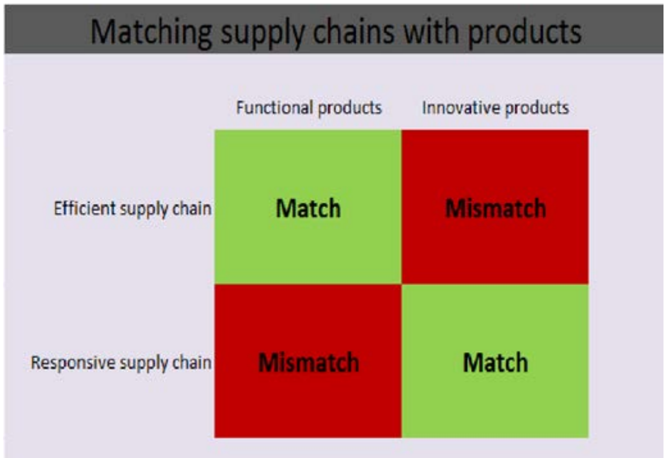

Figure 4: Matrix to formulate ideal supply chain strategy (Adapted from Fischer,1997)

The significance of the selection of an ideal supply chain strategy as dictated by Fisher (1997) are evident in the case study of collaboration with a supplier and the retailer where efforts were made in order to cut costs throughout the chain through continuous replenishment program thereby increasing the cumulative income.

Many firms have made the supply chain optimization their top priority as the supply chain activities often tend to be the major cost drivers. As a consequence, more and more resources are being allocated towards achieving physically efficient supply chain so as to reduce their operational costs (Kerstin et al, 2012). These competitive sustainable advantages can be achieved by managing the interconnections among various organizations in the supply chain network without compromising on the customer service level and market orientations (Schnetzler et al., 2007).

The major differences between different supply chain portfolios are significant in terms of the performance of the supply chain which in turn effects the supply chain decisions including product capacity allocation, inventory policies, geographic dislocation of suppliers, point of sales and decoupling position (Brun & Salama, 2004). When adapting the same concept in the fashion industry, the major factors that drive the competition in fashion industry are product characteristics, retail channel format and brand positioning (Brun & Castelli, 2008). Such supply chain strategy segmentation through a portfolio approach is being presented by the framework model termed as “Segmentation tree” shown in the figure below.

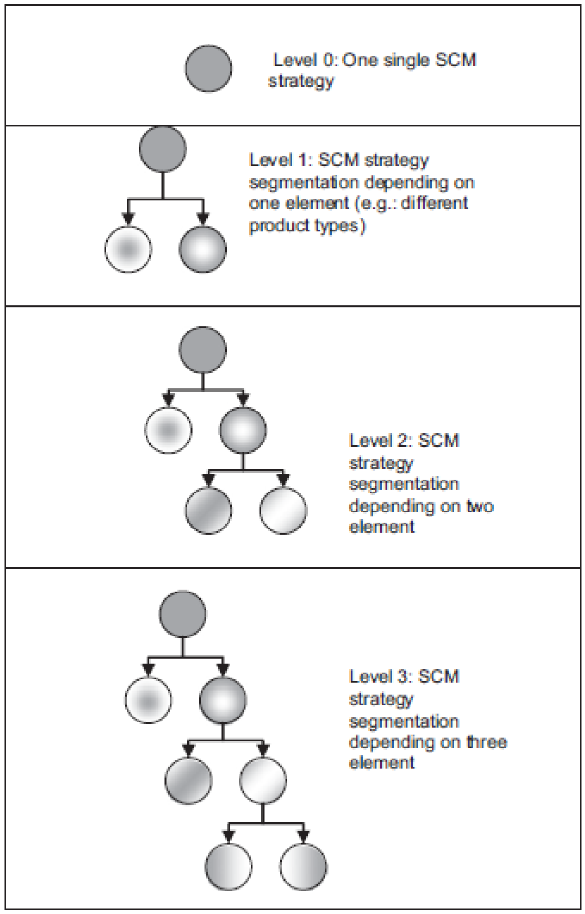

Figure 5: Segmentation tree (adapted from Brun and Castelli, 2008)

The segmentation tree potentially describes extend of segmentation i.e. if it is based on one, two or three major driving factors of the fashion industry.

A product with a stable demand and a reliable source of supply shouldn't be managed in the same way as the one with a fashion product characterized by unpredictable demand and unreliable sources of supply. Also, when a large number of components are needed it would be better to rely on consolidating the purchase from selected suppliers and improve the relationship with them (Brun & Castelli, 2008).

One major feature of an efficient supply chain is an integrated demand pull model which allows the supply chain to have an earlier insight into the actual consumption. This would allow the manufacturers in the chain to align their production and distribution more closely with the actual demand resulting at lower costs with higher service levels. This prevents "forward buying" as anticipatory stocks resulting in higher inventory costs (Scalise, 2005). Large buffers are considered inventories because of decoupling of assembly, storage and distribution into various functional and geographical components. This results in costly consequences which becomes apparent with increasing globalization. This has resulted in the firms moving from a decoupling approach to a better coordinated, integrated design and control of their components so as to lower cost by maintaining a higher service level (Thomas and Griffin, 1996).

A coordinated planning and scheduling can be attained through various operational models namely the Buyer-Vendor coordination, Production- Distribution coordination and Inventory-Distribution coordination (Thomas and Griffin, 1996). The Buyer- Vendor coordination remains significant as the raw material and subassembly costs often accounts for more than 50% of the cost of goods. This coordination could be improved by looking into opportunities for reducing costs without changing the ordering policies. This could be done through investments in material handling systems and data exchange technology like the Electronic Data Interchange (EDI) which would increase the efficiency of the supply chain. One other opportunity to increase the coordination would be savings that could be accrued through finding an order quantity that is jointly optimal for the buyer and the vendor followed by negotiations to determine the split on the savings between the parties involved (Thomas and Griffin, 1996).

LOT SIZING

Lot size models are basically the size of the inventory or the batch size for production (Harris, 1915). The major and the central issues when it comes to lot sizing are the determination of the order quantity and the time of ordering (Krajewski, 1975). While making a lot size decisions, there are two main costs that are associated with it. They are the set up cost and the inventory/holding cost. Thus the total sum of the inventory cost for an item's order schedule would be the sum of these two costs incurred for that particular schedule. The setup costs are normally fixed and are independent of the size of the replenishment. It usually includes cost of processing the orders, authorization, machine set up, tooling and interrupted production. On the other hand, the inventory carrying costs can be largely associated with the opportunity cost of the inventory investment, warehouse expenses, deterioration of stocks, obsolescence, insurance and the taxes (Kim, 1986).

The lot sizing models may be differentiated into independent lot models and the dependent lot models. Since the independent lot models are associated with products with independent demand, they apply only to a single demand pattern. The most common lot sizing models for independent demand items are the Lot For Lot, Periodic Order Quantity (POQ), Economic Order Quantity (EOQ), least unit cost model and the Joint Economic Lot sizing Problem (JELP) model (Krajewski, 1975).

Periodic order quantity (POQ) model is based on the fact that the re-order time interval remains a constant with the order quantities being changed in order to meet the exact demand during the time period (Orlicky, 1975). Least unit cost model (LTC) model equates the total inventory carrying cost along with set up costs (Gorham, 1968). The method goes through the product requirements step by step, accumulating a lot size until a period t, wherein the total carrying cost of the inventory through the time period t becomes closest to the set up costs.

Economic order quantity (EOQ) model was proposed by Harris (1915) and has since then become one of the most widely used lot sizing model in the industry. The model determines the optimal order quantity when the demand remains continuous and the steady state demand is known. Order quantity is based on the reasoning that the minimum cost is at the point where the inventory carrying cost and the setup costs are equal. This model was later redesigned by Wagner & Whitin (1958) to a dynamic version of the Economic Lot Sizing model that yields the optimal order quantities for single level single products. This was done by relaxing the assumption of invariable inventory costs while assuming zero inventories and no stock out situation (Kim, 1986).

JOINT ECONOMIC LOT SIZING PROBLEM (JELP)

With greater significance being given to supply chain management, firms realize that the inventory along the whole supply chain could be efficiently managed through effective coordination and cooperation. After these developments, concentrating on determining the order quantity and the delivery schedule based on the buyer-supplier integrated cost function seems more cost effective than using buyers or suppliers individual cost functions. This approach is termed as Joint Economic Lot Sizing (JELS) and the problem associated with determining the number of shipments and size of each batch so as to minimize the joint manufacturer- retailer cost is known as Joint Economic Lot sizing Problem (JELP) and this problem is considered as the building block of a wider supply chain concept, (Ben-Daya et al, 2008). These policies range from a simple lot-for-lot policy to complex policies which include geometrically increasing multiple shipment sizes.

Assumption and notation

The JELP models at present are based on the following assumptions:

1. Demand rate is deterministic and constant.
2. There are no shortages.
3. Time horizon is infinite.
4. The produced lot is transferred to the buyer in n shipments
5. It is also assumed that the production rate is greater than the demand along with the assumption that holding cost of the buyer is greater than that of the vendor.

Also, the notations used are:

D	demand rate
P	production rate for the vendor
Av	production setup cost
Ab	buyer ordering cost
hv	holding cost for the vendor

hb holding cost for the buyer
Iv average vendor inventory
Ib average buyer inventory
Is average system inventory
qi size of shipment i
n number of shipments
Q production lot size
T inventory cycle length
TP production cycle length
TC average total cost per unit time

The different JELP policies along with their model components are as depicted in Figure 6 below. These models provide a representative set of JELP models for different shipment policies.

Different policies and model components

Policy	Q	I_s	I_b	Optimal $q(q_1)$	Decision variable(s)
Generic model	$\sum_{i=1}^{n} q_i$	$\frac{q_1 D}{P} + \frac{(P-D)Q}{2P}$	$\frac{\sum_{i=1}^{n} q_i^2}{2Q}$	NA	n, q_is
Lot-for-lot (Banerjee, 1986)	q	$\frac{nq}{2}\left[1+\frac{D}{P}\right]$	$\frac{q}{2}$	$\sqrt{\frac{(A_v+nA_b)D}{h_v\left[\frac{D}{2P}+\frac{1}{2}\right]+(h_b-h_v)\frac{1}{2}}}$	q
Delayed equal-size shipments (Goyal, 1988)	nq	$q\left[\frac{D}{P}+\frac{n}{2}\right]$	$\frac{q}{2}$	$\sqrt{\frac{(A_v+nA_b)D}{n^2\left(h_v\left[\frac{D}{P}+\frac{n}{2}\right]+(h_b-h_v)\frac{1}{2}\right)}}$	n, q
None-delayed equal-size shipments (Lu, 1995)	nq	$q\left[\frac{D}{P}+\frac{(P-D)n}{2P}\right]$	$\frac{q}{2}$	$\sqrt{\frac{(A_v+nA_b)D}{n^2\left(h_v\left[\frac{D}{P}+\frac{(P-D)n}{2P}\right]+(h_b-h_v)\frac{1}{2}\right)}}$	n, q
Geometric policy (Goyal, 1995; Hill, 1997)	$\frac{q_1(\lambda^n-1)}{\lambda-1}$	$q_1\Psi_1(n,\lambda)$	$\frac{q_1(\lambda^n+1)}{2(\lambda+1)}$	$\sqrt{\frac{(\lambda-1)(A_v+nA_b)D}{(\lambda^n-1)\left(h_v\Psi_1(n,\lambda)+(h_b-h_v)\frac{(\lambda^n+1)}{2(\lambda+1)}\right)}}$	n, q_1, λ
Geometric-then-equal (Goyal and Nebebe, 2000; This paper)	$q_1\Psi_2(n,m,\lambda)$	$q_1\Psi_3(n,m,\lambda)$	$\frac{q_1}{2}\Psi_4(n,m,\lambda)$	$\sqrt{\frac{(A_v+nA_b)D}{[\Psi_2(n,m,\lambda)]^2(h_v\Psi_3(n,m,\lambda)+(h_b-h_v)\Psi_4(n,m,\lambda))}}$	n, m, q_1, λ

$\Psi_1(n,\lambda)=\left[\frac{D}{P}+\frac{(P-D)(\lambda^n-1)}{2P(\lambda-1)}\right]$; $\Psi_2(n,m,\lambda)=\left[\frac{(\lambda^m-1)}{\lambda-1}+(n-m)\lambda^m\right]$; $\Psi_3(n,m,\lambda)=\left[\frac{D}{P}+\frac{(P-D)}{2P}\left[\frac{(\lambda^m-1)}{\lambda-1}+(n-m)\lambda^m\right]\right]$; $\Psi_4(n,m,\lambda)=\left[\frac{\lambda^{2m}-1+(n-m)\lambda^{2m}(\lambda^2-1)}{(\lambda+1)[\lambda^m-1+(n-m)\lambda^m(\lambda-1)]}\right]$.

Figure 6: Different JELP policies and models (Adapted from Ben-Daya et al, 2008)

The different JELP models are described as follows:

LOT-FOR-LOT POLICY

This model with a finite production rate was proposed by Banerjee (1986). It has each of the production lot send to the buyer as single shipment implying that the entire production lot is to be ready before shipment. It provides a period by period coverage of the net requirements thus minimizing the workload variations on a weekly basis (Orlicky, 1975).

EQUAL SIZED SHIPMENT POLICIES

In these policies, the shipment sizes remains the same implying Q=*nq* i.e. the production batch size is split into equal size smaller shipments. These policies are easy to implement which makes them attractive and can be further differentiated into two models, “the delayed equal sized shipment policy” and “non-delayed equal sized shipment policy”. The former model is characterized by the shipment happening only after the production batch is completed and has the whole production lot being divided into quantities of size *q* which are then shipped in *n* shipments (Goyal, 1988). However, the latter policy differs from the delayed equal sized shipment policy in the fact that the first shipment of q quantity is shipped in the during the production (Lu,1995). This proves to beneficial when the production lead times are long.

GEOMETRIC SHIPMENT POLICY

Developed by Goyal (1995), this model has successive shipment with the production lot increasing by a factor γ, where γ is the ratio of production rate to the demand rate. The second variety of the geometric model termed as equal shipment policy was developed by Ben-Daya et al (2008). It is structured in such a way that the first *m* shipments increases according to a geometric series based on the factor γ. Then the remaining (*n-m*) shipments are of equal sizes.

INVENTORY MANAGEMENT

Jones and Riler, (1984) states that the key to efficiently manage a supply chain is to plan and control the inventories and the associated activities as an integrated single entity. Three elements which are significant towards the integrating supply chain to work effectively are:

- Recognizing the service level requirements
- Defining on where to position the inventories and how much to stock at each point
- Employing appropriate policies and procedures for managing the supply chain as a single entity.

As a result of the increasing demand from the customer regarding the service levels, the supply chain is required to increase the amount of resources being employed which comprise inventories, transportation, facilities and workforce. Therefore the main objective of integrating the supply chain is to lower the total amount of resources required to provide the necessary service level as depicted in the figure 7 given below.

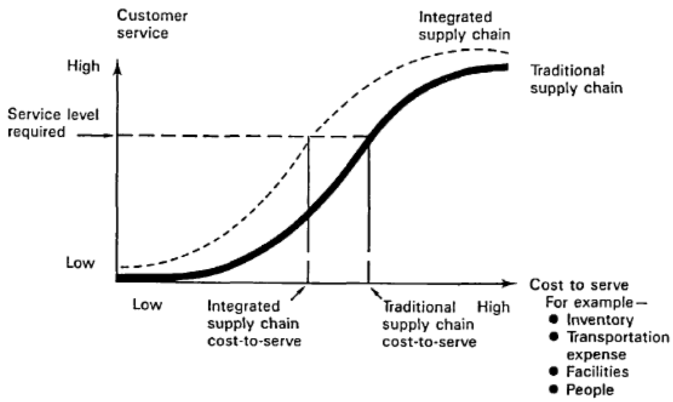

Figure 7: Traditional versus integrated supply chain resource utilization (adopted from Jones and Riler, 1984)

The second stage of the integration is to evaluate alternate stocking points without affecting the overall cost-to-serve. Further on, the final stage for integrating a supply chain is then to develop and install the necessary policies, organizational relationships, systems and controls needed to control the supply chain as a whole.

Inventory can be defined as one or more items of a physical nature en route to the final customer from the primary location which currently is not going through any transformation. (Howard, 2007).

When it comes to items with independent demand, their demand characteristics are normally unrelated to any other item. Their inventory (the independent demand inventory or the distribution inventory) are mostly maintained in the manufacturing finished goods warehouse, regional distribution centers, local distribution centers and the retail outlets.

REPLENISHMENT SYSTEMS

In the recent years, there has been a dominant belief that large pile of goods displayed in the marketplace leads the customers to buy more and thus there has been considerable attention to the situation where the demand is more dependent on the level of on-hand inventory (Uthayakum and Geetha, 2009). Thus it becomes imminent for the retailer to offer a large portfolio of products and maintain inventory for all of them. This remains the same case with the fashion retailers as well. This is possible only with a proper inventory management and associated replenishment methodologies.

According to Tokar et al (2012), the cost efficiency within a supply chain depends on the replenishment decisions within a dynamic and interactive system and therefore the quality of these decisions is a primary issue for the managers. Thus a sound and efficient inventory management system becomes critical to the strategic viability of firms such as Walmart, Toyota and Dell (Zipkin, 2000).

THE REORDER POINT SYSTEM

The re-order point strategy treats demands at all echelon in the supply chain as independent. The inventory replenishments are generally based on the following factor which incorporates physical inventory, backorders, order released to the suppliers but are not yet filled and the shipments in transit. This provides partial visibility of inventory positions to the upstream locations and helps to expedite order releases under the shortage conditions.

The inventory position in ROP is reviewed on a regular basis so as to incorporate a new event affecting the system during a new order release (Suwanruji, 2004). In this type of replenishment system, the reorder point is calculated as the predetermined inventory level at which the replenishment system is triggered when the on hand stock drops below that level.

Re-order point = Anticipated demand during the lead time + safety stock

Here, the forecasted demand is multiplied with the lead time in order to obtain the anticipated demand. The safety stock is the buffer in the demand side which absorbs the uncertainties in the demand (Howard and Walter, 1990) and is calculated as

$$\textbf{Safety stock} = k^* \sqrt{(t.s_d^2 + d^2 s_t^2)}$$

Here,

k	Dimensionless safety factor
t	Average lead time
s_d	Standard deviation of the past demand
s_t	Standard deviation of the lead time
d	Average demand per period

The inventory level graph of a traditional reorder point system is a saw tooth inventory profile and is as shown in the figure 8 below. The order is placed when the stock goes below the reorder point so that the new shipment arrives by the time the inventory reaches the safety stock which is 200 units in the example provided below.

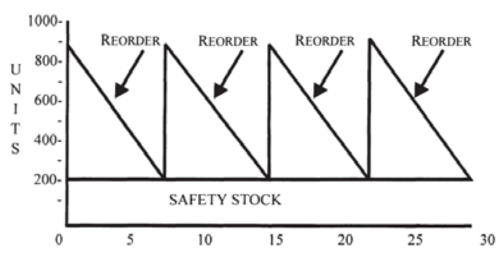

Figure 8: Inventory for reorder point replenishment

Time phased order points

This replenishment model is employed for the planning and control of independent demand products which have non-continuous demand. They are in general used for the finished parts goods and service parts control. The model engages the standard Material resource planning logic of determining the net requirements by the time period.

Periodic review systems

This model is based on the principle of placing an order on a fixed time interval basis. The ordering schedule here is based on the planned supplier ordering patterns. The advantage with the model lies in the fact that it generates single purchase order while providing opportunities for ordering the slow moving items in small quantities as well. It is generally employed by the branch warehouses to place replenishment order on a scheduled basis and normally placed to meet a target level.

Factors which determine the target quantities are the forecast, lead time, the review period and the safety stock. It is also characterized by higher safety stock levels owing to the forecast variations happening during both the lead time and review period.

METHODOLOGY

This chapter describes on how this thesis work has been done. It starts with discussions on how the study was designed based upon the different research approaches considered. It then describes on how the relevant literature research was done in relation to each of the research questions. This is followed by discussion on the methods used for data collection, how data collection was done and on how they were analyzed. Lastly, the chapter finishes by examining the reliability and validity of the studies.

STUDY DESIGN

A case study methodology was chosen to define and analyze the NOOS products at Ellos AB. The aim of the case was to provide a profound understanding on the characteristics of the NOOS products and enable the author to split the thesis work into segments for ease of working. This case study is normative since it involves collecting and analyzing data so as to provide improvement possibilities for the object of study thus promoting the future development (Cohen et al, 2007).

The first step was to define the research approach for the case study to be done as a part of the thesis. Normally, two methodologies are used for conducting research projects closely tied with the industry and they are the deductive and inductive approach (Saunders et al, 2009; Dubois and Gadde, 2002b). The deductive approach has the research study starting with the formulation of a theoretical framework followed by the analysis of the research finding. Whereas, in the inductive approach the theoretical framework emerges from the empirical findings (Saunders et al, 2009; Dubois and Gadde, 2002b). In the present thesis, both the approaches are combined to form what is known as the systematic combining (Dubois and Gadde, 2002). Such an approach was used as the first phase of the thesis i.e. the product segmentation of Ellos AB product portfolio resulting in the defining of NOOS products was based on a combination of the theoretical data and the empirical data. Later on, the analysis phase was mostly based on the theoretical study. The systematic combining in fact enables triangulation (Yin, 2003) and secures the quality and relevance of the study (Dubois and Gadde, 2002).

Another decision in the study design was whether to follow a qualitative or a quantitative research approach for gathering the empirical data for the thesis. According to Bryman & Bell (2007), the quantitative method majorly emphasizes the numerical data and has an objective orientation whereas the qualitative approach emphasizes on words and meanings. In this thesis, both the methods complement each other even though the quantitative approach dominates. The required quantitative data (historical sales and associated data) was extracted from the Ellos Enterprise Resource Planning (ERP) system whereas; the qualitative data was collected through interview and continuous discussions with the concerned official at Ellos AB.

The research work was mainly divided into three phases where the first phase defined the NOOS products at Ellos AB through product segmentation. It was then followed by the second phase which included the analysis of the defined NOOS products by the study of the demand characteristics, data analysis and other parameters like gross margin, lead time, Cost Of Goods Sold (COGS). Further on, the third phase included research work into possible optimization techniques. This was then followed by recommendation for improvement for NOOS product material flow so as to reduce the average inventory and tied up capital through a better management of the associated material flow.

RESEARCH LITERATURE REVIEW

The literature review started once the author along with the supervisors established the purpose of the thesis. Initially, literature on supply chain portfolios in textile industry and product segmentation was gathered and was later narrowed down to specific topics in the focus area. The literature review allowed building up a framework to understand the relevance and significance of product segmentation in the textile industry and Ellos AB in special. Literature study was also done to understand the product characteristics of NOOS products thus helping to answer RQ1, RQ2 and RQ3. Further on, literature on different order, planning and control strategies was reviewed in order to answer the RQ5. Since being a normative study, the literature gathered allowed proposing recommendation to company based on the needs observed thus serving as the answer of RQ5 partially and RQ6 and RQ7.

The literature which formed the base of the theoretical framework was mainly obtained from the search engine provided by the Chalmers University of Technology library and Google Scholar. The Chalmers Library search engine comprises multiple databases and thousands of E-journals. The major databases which provided the best results were; Books 24x7, Emerald, Science Direct and ProQuest. Along with the systematic combining research mentioned earlier, the analytical framework was continuously revised as relevant topics emerged or the previous topics were no longer applicable.

DATA COLLECTION

According to Patel and Davidson (2011), there are two kinds of data that can be collected in a case study, namely the primary data and the secondary data. Primary data refers to undocumented sources, which includes interview and discussion of various types. The core of the empirical data gathered for the thesis work was from primary sources which included extraction of the relevant data from the Ellos AB data base as well as open, semi structured interviews with the concerned at Ellos AB. On the other hand, the secondary data refers to documented sources such as articles and books. These data was compiled through company reports, confidential documents and presentations. The data that is being published in this report is relevant to the defined research questions and thus will fulfill the purpose of this thesis. During the thesis, additional data was collected by the author who provided better insights into the company's operations. Such additional data has been excluded from the main report since it doesn't directly relate to the research questions established.

HISTORICAL DATA FROM ELLOS AB

In line with the quantitative nature of the research work, data extraction from the Ellos AB data base was done for obtaining the quantitative empirical data. The quantitative gathering helped the author to familiarize and have a bigger picture on the complete portfolio of the textile retailer. Further, it led to the identification of problems faced by the company regarding the NOOS products in detail. In this way, it was possible to go deep into the specific areas of special attention.

Design and data analysis

Historical sales data along with other significant details such as COGS, season of sales, units sold etc. were extracted as a part of the first phase of the thesis work. It was important to limit the number of products which were to be categorized into NOOS product segment. Finally, an ABCD analysis was done on the available data after the primary categorization in order to prioritize high selling products. The ABCD analysis was done as they helped the author to identify and concentrate on the items which help create a surplus value (Rusănescu, 2014). In essence, ABCD analysis is a method of which helps in dividing inventories or the suppliers into different categories based on the cost/unit parameter or the quantity held or turned over a period of time. It also helps in deciding on different inventory/supplier management techniques to be applied for different segments on the inventory /suppliers so as to increase the revenues and decreasing the costs incurred. Ideally, the A category items represents approximately 15-20% of the overall inventory by items but corresponds to 80% of the inventory value. At the same time B category corresponds to 30-35% of the inventory by items while corresponding to 15% of the value and the rest of the inventory is categorized into the C class which is valued at the remaining 5% of the total value of the inventory (Rusănescu, 2014).

However, as Ellos AB had a predefined ABCD analysis system, the inventory categorization according to the value generated by the products was entirely based on the ABCD standards as set by Ellos AB and they are as represented in the below table.

Table 2: Ellos ABCD Classification

Ellos ABCD classification		
Classification	Demand	No of products
A	30%	10%
B	40%	30%
C	20%	30%
D	10%	30%

Second phase on the other hand which mainly dealt with the analysis of the defined NOOS products demanded much deeper and detailed data. Therefore further data was obtained from the ERP system of Ellos AB. This included details like order frequency, order quantity, mode of transport, supplier details. Further on, certain parameters had to be calculated from the primary data obtained from Ellos AB. These included calculation of gross margin, average lead time, product life cycle.

INTERVIEWS

Discussions were done on a regular basis throughout the thesis as a part of updating the thesis status to the Ellos AB management. This was followed by interviews of the concerned officials so as to validate the empirical findings. Also, the data collected from the interviews complimented the quantitative data analysis while taking decisions during different phase's i.e. definition of NOOS, selection of supply chain strategy etc.

The initial interviews conducted were of an open nature. Open interviews served as an open discussion upon the topic of interest (Dunn, 2005). In this way, it was possible for the interviewee to discuss freely upon matters that they think would be relevant to the topic of discussion. The follow up questions were neither standardized nor prepared but based on the answer of the interviewee (Yin, 2003). Open interviews with the Director of Sourcing & Supply, Supply Chain Developer and the Stock Controller at Ellos AB were carried out during the early stages to identify the need of the thesis project and to define the scope of the research. These open interviews also gave the author a general understanding of the company's position and how the different products are dealt within the whole supply chain. These also resulted in suggestions on who to interview for additional information as the research progressed.

The open interviews were then followed by the semi structured interviews guided by open-ended questions as the research work progressed. In this stage, the interviewees covered a set of previously prepared questions but further questions were added during the interviews in response to what the author thought would lead to information needed for the next stage of the research work (Bryman and Bill, 2003;Yin, 2003). These semi structured interviews were used to direct the gathering of the required data towards answering the research question set by the thesis work. These interviews with the NOOS stakeholders helped the author to evaluate the significance of product segmentation at Ellos AB.

Design and data analysis

Since the case study is based on Ellos AB's purchasing department, majority of the interviews were conducted with the individuals belonging to this department. Two types of semi structured interviews were conducted. Both the interviews were similar in structure but adaptations were made depending on the relation of the interviewee's towards NOOS products.

The first type of interview was conducted with the Stock Controller and the Supply Chain Developer so as to obtain a holistic view of NOOS product purchase done by Ellos AB. The major areas of interest were the perception of NOOS at Ellos AB. The second types of interviews were conducted during the second phase of the thesis work. The Product Buyers and Stock Controller were interviewed and were more specific in nature. It included topics like the guidelines for buyer while placing order for the NOOS products. The inventory management guidelines for NOOS products were also discussed. Both the type of interviews was then followed by a brainstorming sessions about the improvements possible and discussion on how to reduce the tied up capital & inventory for the NOOS.

RESEARCH ACCURACY

In order to demonstrate the trustworthiness of the research findings, it is significant for the author to reflect upon the validity and reliability of the gathered data throughout the project (Robert et al, 2006). Therefore the author has spent significant time on reviewing the incorporated data and discarding the empirical finding that were irrelevant to the research work. Further, the author has had weekly follow up meetings with the supervisor at Ellos AB and monthly meetings with the supervisor in Chalmers in order to update about the status of the thesis and discuss the findings. In addition, the author has had numerous presentations for the officials at Ellos AB to make sure that the thesis was in alignment with the interests of the NOOS stakeholders. In addition, the author has also adopted a multi strategy research design with triangulation to ascertain the confidence of the findings. This has been done through the classification as specified by Bryman and Bill (2003). The data triangulation has been done by gathering data at different points of time in person. Also, the usage of two major methods for data collection i.e. historical data from Ellos AB database and interviews, has allowed in validating the empirical data that was collected by either of the methods. The data accumulated through interviews were confirmed with the data extracted from Ellos AB database and the same trends were observed.

EMPIRICAL FINDINGS

This chapter starts by presenting the basis sales details of Ellos AB for the financial year 2013 followed by details on the contribution of various product segments in the sales at Ellos AB. Further on, the distribution of different types of products as differentiated by the author is explained in detail along with the graphs. This then would proceed to the ABCD analysis of the potential NOOS products selected through the analysis of the historical sales data. The definition of the NOOS product segment would then be followed by graphical representations provided for the current order, planning and control policies at Ellos AB.

PLANNING GROUPS

The first step towards analysis of the historical sales data of Ellos AB was to understand the contribution of various planning group to the total turnover of Ellos AB. Here the planning groups at the company have been divided into internal products, external products and the collection sharing products. Internal products constitute all the products which are designed, manufactured and sold by Ellos AB whereas the external products includes products from numerous other brands like Adidas, Nike, Converse which are being sold through the Ellos AB online website. Collection sharing on the other hand constitutes of the products which are produced the previous owners of Ellos Group. The sales generated by each planning group by the internal, external and collection sharing products are as shown below in figure 9 and figure 10.

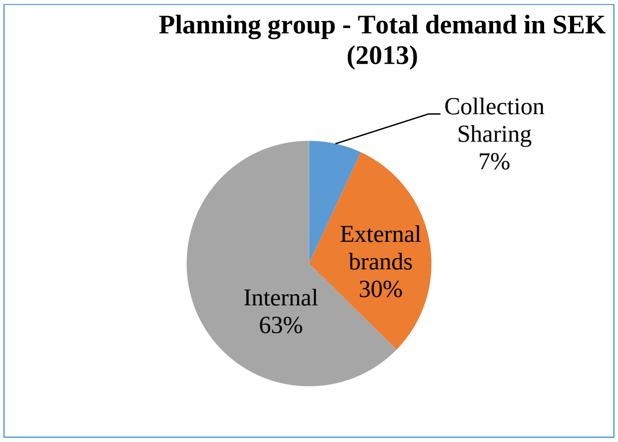

Figure 9: Planning growth - Total demand in SEK (2013)

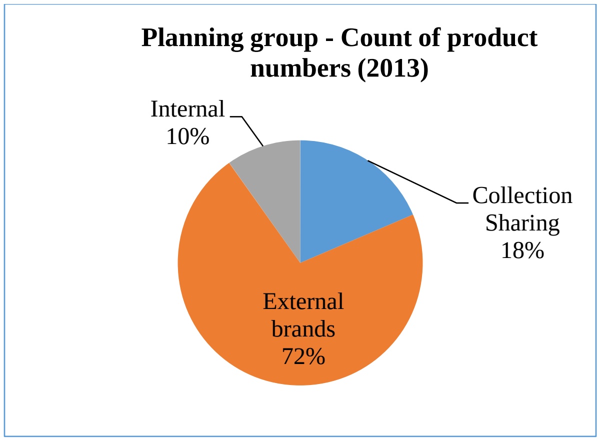

Figure 10: Planning group - Count of product numbers (2013)

It can be understood from the above piechart's that the internal products (i.e Ellos products) produces the maximum sales at Ellos AB with the internal products (10% of the entire portfolio) bringing in 63% of the total revenue for the company during 2013.

PRODUCT SEGMENTATION

As specified in the literature before, it is essential to differentiate the products in the portfolio into different segments according to various parameters like demand characteristics, lead times for production, COGS etc. Therefore in line with the theoretical recommendation, the entire Ellos AB product portfolio was differentiated into various segments primarily according to the number of seasons they are being sold by the company. In order to avoid any short term impacts on Ellos AB during the analysis of the historical data, sales data from 2011 until 2014 was extracted from the Ellos AB database for product segmentation.

The whole product portfolio was categorized into four product segments. The different product segments are Fashion products, Basic Products, Potential NOOS products and the Carry forward products (CFWD). The products classified as the fashion products are being primarily sold for only one season (SS or AW). Basic products are the one which are being sold by Ellos AB for two seasons. The carry forward products are the seasonal products which are being sold only in a particular season i.e. either AW or SS. The products which are being sold only during the Autumn-Winter season are termed as CFWD (AW) and the ones sold during the Spring-Summer as CFWD (SS). The potential NOOS products on the other hand are all those products which are being sold for more than three seasons since 2011. The contribution of each product segment in terms of the revenue produced and season wise sales from historical data from 2011-2014 are shown in figure 11 and figure 12.

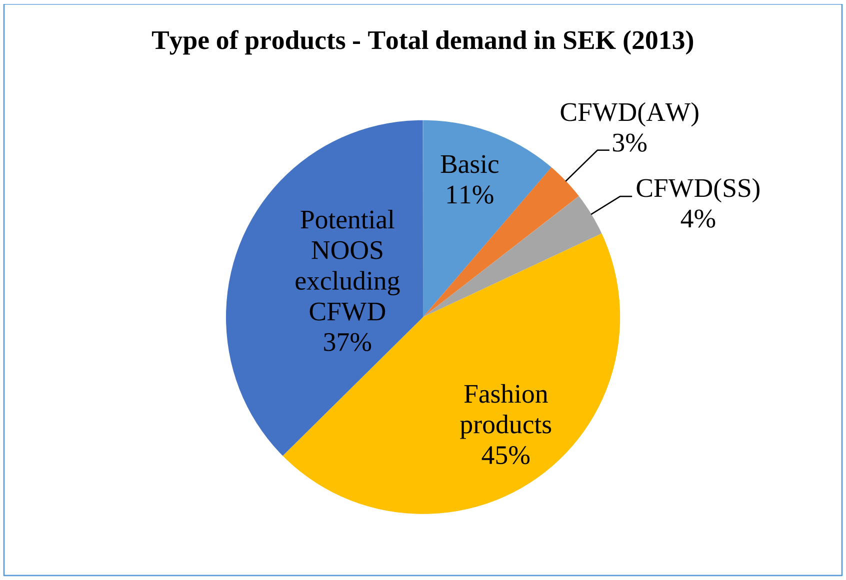

Figure 11: Product segments at Ellos AB

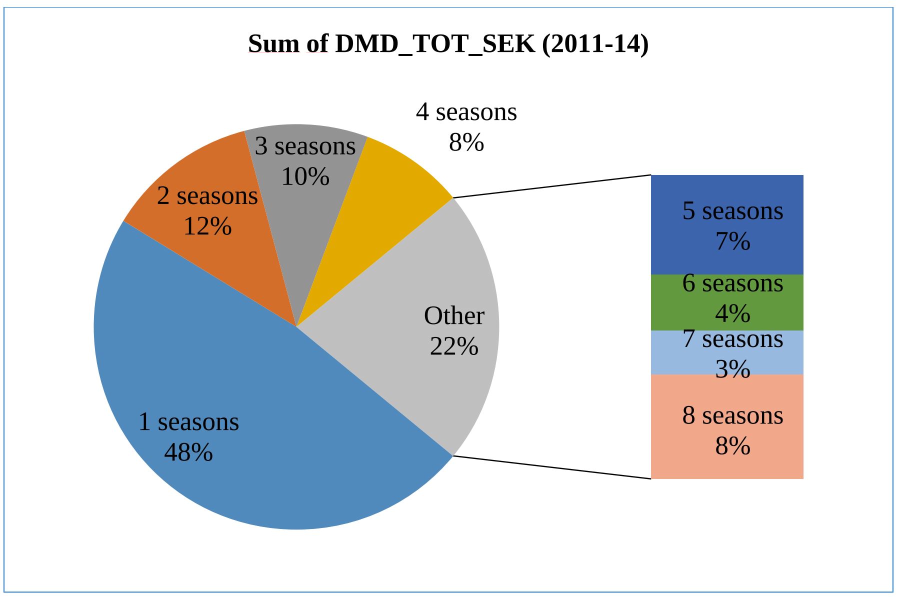

Figure 12: Season wise sales of Ellos AB products

ABCD Analysis

After the product segmentation, there were around 3310 products which were categorized as potential NOOS. Since it was difficult to analyze the properties of all the 3310 products with regard to their characteristics, it was important to further narrow down the scope of analysis. Thus an ABCD analysis was done on the sales values of the potential NOOS products for the financial year 2013 in order to identify the products that were significantly contributing to the NOOS total turnover.

An ABCD analysis as described in the earlier section was done and the results are being consolidated in the below table 3. As a result of the classification, all those products which were sold for more than 2.5 Million SEK were included in the A category with the B category products being sold in the 600 000-2.5 Million SEK range. The C products constituted the products which were sold between 150 000 to 600 000 SEK and all the products which were sold below 150 000 SEK were classified as D products (See Table 4).

Table 3: ABCD analysis of potential NOOS products

Classification	Ellos Demand %	Ellos Demand(SEK)	Calculated demand %	Calculated demand (SEK)
A	30%	285 000 000	30,14%	286 355 954
B	40%	380 000 000	39,99%	379 895 787
C	20%	190 000 000	21,66%	205 786 824
D	10%	95 000 000	8,21%	77 961 435
	Grand total	950 000 000		

Table 4: Categorization of groups after ABCD analysis

Category definition	
Category	**Demand in SEK**
A	Above 2,5 Million
B	600 000 - 2.5 M in sales
C	600 000 - 150 000 in sales
D	150 000 - 0

It was noted that, the products in the A segment which constituted 2.3% of the entire potential NOOS products (i.e. 75 products) contributed to 30% of the total NOOS sales in 2013 and the B segment which had 10.2 % products from the entire NOOS portfolio contributed to 40% of the total sales in 2013. To summarize, Ellos AB had 70% of the revenues from products sold for more than 3 seasons from 2011-2014 being generated from a meager 12.5% products (i.e. 411 products from a total of 3310 products produced 70% revenues).

Table 5: Number of products included in each category of ABCD analysis

Classification	No of products %	No of products
A	2,3%	75
B	10,2%	336
C	19,5%	645
D	68,1%	2254
	Total	**3310**

ORIGINAL DEMAND VS. STOCK DATA AT ELLOS AB FOR 2013 FINANCIAL YEAR

The understanding of present planning and control policies for the NOOS products at the company is significant to move further into the analysis phase of the thesis work. The present scenario provides the base for structuring the analysis and would help in documenting the benefits of the provided recommendation in an organized manner.

The figure 13 is a graph which elaborates on the demand Vs stock situation at Ellos AB for a high selling product. This is expected to provide an understanding of the efficiency of the policies that are being employed by Ellos AB to control their material flow. The effectiveness of the current replenishment system can also be understood from the demand to stock ratio, inventory turnaround data and shortage situations.

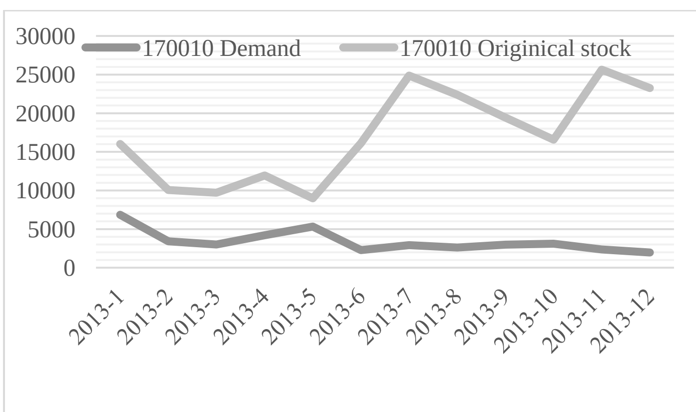

Figure 13: Stock Vs Demand graph for product no: 170010

TRANSIT COST

Currently, a non-standardized replenishment system is being used by Ellos AB for all its products. This replenishment system doesn't account for any safety stock which leads to frequent stockouts owing to unexpected fluctuations in the demand pattern. In an effort to maintain a satisfactory service level, Ellos AB is often needed to transport its finished goods through air freight which leads to high transit costs. The transport cost incurred for high selling products on different modes of transport are depicted in the figure 14.

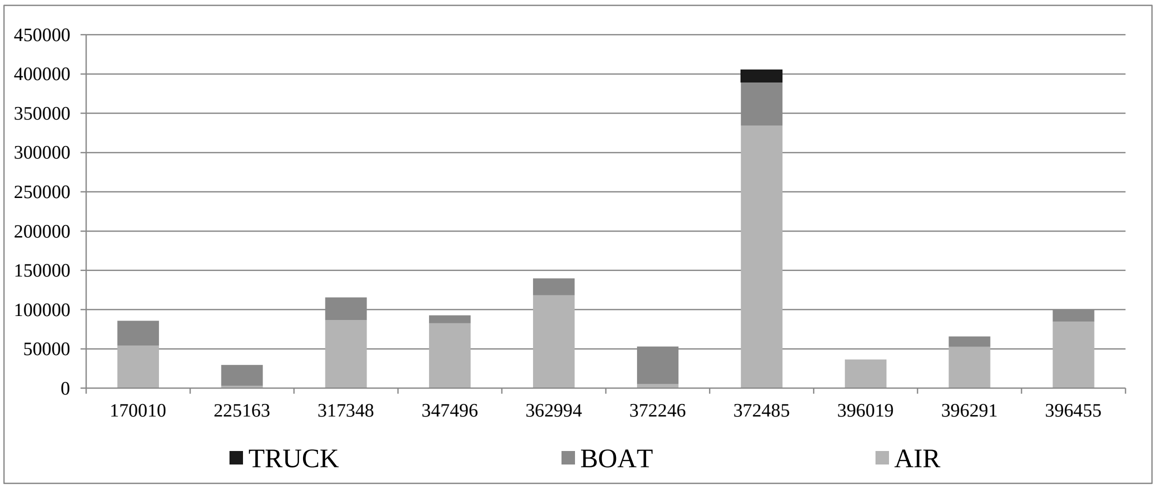

Figure 14: Transit cost split for different modes of transport

ANALYSIS

This chapter will discuss and evaluate the current product segmentation and the associated material planning existing at Ellos AB. It would also provide details on the present material planning processes being employed by Ellos AB. The theoretical framework of this research work and the historical data analysis from the empirical section would serve as the baseline for the analysis. The chapter begins with the present product segmentation at Ellos AB. Further on, the author presents the problems identified in the current segmentation. This will then be followed by the evaluation of alternate material planning principles and their feasibility when the company's supply chain is considered. The last section is dedicated for the discussion upon the author's suggestions to reorganize the product segments and then employ a suitable material planning and replenishment system which would help reduce the inventory there by reducing the tied up capital. Since the thesis work is done on the definition and analysis of the NOOS products, the discussions would be significantly attributed to the NOOS product segment.

SUITABILITY OF PRODUCT SEGMENTATION AT ELLOS AB

The mission of this thesis work is to evaluate the feasibility of product segmentation of the product portfolio at Ellos AB. The first step of the analysis would be to understand the present scenario of product categorization being followed by the company. The beneficial prospects of employing product segmentation as dictated by Fisher (1997) will then be discussed. This would include discussions on benefits that can be accrued through implementation of different supply chain strategies (i.e., material planning and associated replenishment systems) for different product segments.

CURRENT PRODUCT SEGMENTATION AT ELLOS AB

The first phase of the thesis work was to understand and clearly define various product segments at Ellos AB. Therefore, it was important to understand the approach that was taken by Ellos AB in the past when it came to categorizing their product folio. It was understood from the data accrued through various interviews held with the concerned officials that there were two major categorization of products at Ellos AB namely the fashion products and the base products.

The fashion products included all those products which were marketed to have a short life cycle of 3 and 6 months i.e. these were products which were sold only for one season (either SS or AW). The second segment termed as the Base products contained rest of the products in the Ellos AB product portfolio. All the products which were sold by the company for more than one season were included in the Base category.

PRODUCT SEGMENTATION IN THEORY

As seen in the theoretical framework, Lam and Postal (2006) has stated that it is very significant to have a clear cut definition of product segments within the entire portfolio being offered by the retailer. This according to Fisher (1997) helps device appropriate supply chain strategies for different segments. Various product segments can have very distinct demand characteristics ranging from short product life cycle to long product life cycle, stable demand to highly seasonal and fluctuating demand. Thus it becomes imperative to adopt the most suitable supply chain strategy aligning to the character exhibited by the segment. A faulty adaptation of a strategy for a product segment could lead to improper planning resulting in shortage or overstocks.

Lam and Postal (2006), states that segmentation of products into functional & innovative products and employing suitable supply chain strategies for each segment would help reduce the stock level in the downstream for the retail industry.

SUITABLE PRODUCT SEGMENTATION AT ELLOS AB AND THEIR BENEFITS

The theoretical framework can be combined with the empirical data in order to precisely define product segments according to their demand characteristics. Various product segments which can prove effective at Ellos AB are as follows: The fashion products, the basic products, the NOOS products and the carry forward (CFWD) products. Fashion product segment would contain all the products which would be sold only for one season. Basic products would then include all the products which were sold for only two seasons by the company. The product segment of carry forward products would include all the products which were sold for more than one season but at the same time sold only during a particular season i.e. they have seasonal demand characteristics. The CFWD products could be further differentiated into CFWD Autumn-Winter and CFWD Spring-Summer products. Further on, the NOOS product segment will have all the products which were being sold by Ellos AB for more the 3 seasons and being sold throughout the year.

The major benefits of adopting complementing supply chain strategies for different segments at Ellos AB is to carry out better material planning for these defined products. If properly managed and coordinated, the inventory levels at both the vendor and the buyer end could be significantly reduced without compromising on the service level towards the customer (Fisher, 1997; Lam and Postel, 2006). These include the ability to adapt the most suitable order, planning and control systems which would help planning the order quantities close to the real demand. This would significantly help in avoiding situations of overstock or shortage of the items (Bruce and Daly, 2004). This would also help attain a better transparency in the supply chain and facilitate the supplier to plan their resources in advance so as to reduce the total supply chain cost thereby benefiting all the actors in the supply chain (Schnetzler et al, 2007). This section of the report thus answers the first research question on the product segmentation possible for the Ellos AB portfolio.

MATERIAL PLANNING MODEL

Taking a firm decision on order placements can result in two scenarios, one scenario wherein there occurs a shortage of supplies which might result in loss of customer and the other one where the demand fall short of the supply ending up in overstock (Cachon & Terwiesch, 2008). Thus an efficient material planning system in place will help the company plan and coordinate their material flow which can help them match the supply with the demand without incurring additional cost. The coordination could be further enhanced by adopting a sustainable supply chain strategy by taking into account the entire product portfolios (Kerstin et al, 2012).

Since the second phase of the thesis is to analyze the NOOS material flow, it was essential to understand the material planning processes employed by Ellos AB. The pros and cons of the implemented material planning system would then be evaluated to understand the shortcoming of the present policies which leads to recommendations for an improved order, planning and control system.

PRESENT MATERIAL PLANNING SYSTEM FOR NOOS PRODUCTS AT ELLOS AB

The order placements at the company at present is being done with the assistance of a system support called 'Tell Us' that was developed in house and is being used since 2007. 'Tell Us' was built when the major sales channel at Ellos AB was through catalogues but was later adapted for the online sales channel as well. The inputs for the system support includes data on the historical demand and returns per week along with the in transit purchase orders on an SKU level thereby taking into consideration both the product color and product size criterions. The system takes all these inputs into consideration and provides outputs on the forecasted demand & returns on a weekly basis along with the seasonal surplus or deficits. These weekly output data are then extrapolated to a longer time period. Thus estimation on the future stock levels and the associated demand are done which leads to calculation of order quantities needed to maintain the supply-demand balance. This description on the present order, planning and control policies at Ellos AB answers the third research question.

At present, a common material planning system is being employed for the entire portfolio of the company. This is contradiction with the theoretical recommendation of adapting different supply chain strategies for different product segments with varying demand characteristics. Upon detailed analysis, it is understood that material planning system doesn't consider the demand characteristics of the products which often results in large overstocks or acute shortages with order backlogs. Another main shortcoming of the model is its inability to take into consideration the lead times associated with each product which makes the order, planning and control of NOOS products more difficult. Along with these main shortcomings, the present model requires extensive resources for order calculation every time which is contradiction with company's preferences of allocating more resources for forecasting interested. All these shortcomings thus answers the question posed by the fourth research question.

MATERIAL PLANNING MODELS IN THEORY

NOOS product segment contains products which are characterized by stable demands. According to Brun & Casttelli (2008), these products are not to be managed in the same way as the fashion products that are characterized by unstable and unpredictable demand characteristics. A suitable supply chain strategy can be selected based on the matrix devised by Fisher (1997) depicted in figure 15.

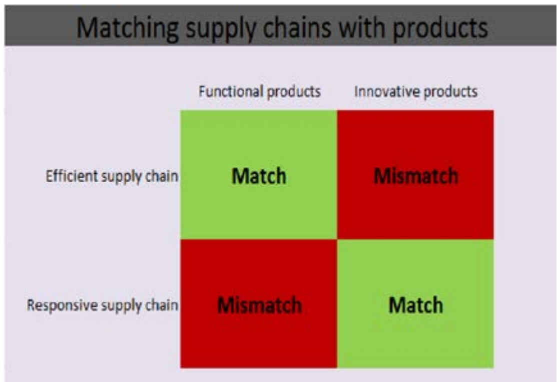

Figure 15: Matrix to formulate ideal supply chain strategy (Adapted from Fischer,1997)

Since NOOS products are functional products, an efficient supply chain strategy is to be adapted for the NOOS product segment. The efficient supply chain model for the NOOS products should be an integrated demand pull model allowing the supply chain to have an insight into the actual consumption. This would therefore allow the manufacturers to align their production and distribution more closely with the actual demand resulting in lower costs with higher customer service levels thus preventing forward buying (Scalise, 2005).These coordinated planning and scheduling can be attained through various operational models through buyer vendor coordination. One opportunity of doing so is to determine an order quantity that is jointly optimal for the buyer and the vendor (Thomas and Griffin, 1996).

Such mathematical models could be developed taking into consideration the nature of demand the products exhibit i.e. if they have dependent or independent demand. Since majority of the NOOS products are items with independent demand, different lot sizing models such as Periodic order quantity, Economic order quantity (EOQ), and Joint Economic Lot Sizing Problem (JELP) are valid for consideration (Krajewski, 1975).

SUITABLE MATERIAL PLANNING SYSTEMS FOR NOOS PRODUCTS

As part of the change in the organization structure, there have been various initiatives withat Ellos AB in order to streamline the customer demands to the current product portfolio being offered. One of these is the implementation of a standardized ERP module into the company's supply chain for a better management of stocks so as to facilitate better planning and control. Also, more resources are being allocated in order to provide more precise input values to forecasting the demand accurately rather than have an automated forecasting with more manual calculations being done for order calculations as done previously. Thus Ellos AB is looking forward to develop a model which will provide pre-calculated order quantities for products so that they would be able to dedicate more resources into the forecasting process.

The periodic order quantity model dictated by Orlicky (1975), remains invalid in this scenario as the model has the re-order interval remaining a constant with the order quantities changing every time according to the demand pattern. This if implemented would revert back to the task of extensive calculation of order quantities every time an order is to be placed resulting in more resources being employed for order calculation rather than accurate forecasting process. Economic order quantity developed by Harris (1915) on the other hand is a plausible model. Ellos AB has majority of their supplier network in the Asian continent with large lead times. Therefore, even though the EOQ quantities are small enough to maintain a smaller inventory level, the large number of shipment (more than 4 shipments every month) makes the model invalid from a logistics point of view at Ellos AB. On the other hand, the JELP which constitutes a set of different models catering to different characteristics comes out as the most applicable model at Ellos AB (Ben-Daya et al, 2008).

The Lot for lot model which is based on calculating the production batch size for the vendor which would then be shipped to the vendor as one single shipment can be considered for the NOOS products. Also, the model of delayed equal sized shipments which calculate the production batch size for the vendor and then splits the same into equal sized shipments would prove beneficial both in terms of reducing the inventory at Ellos AB and calculating the ordering quantities with minimal inputs (Ben-Daya et al, 2008).

REPLENISHMENT SYSTEMS

Following the popular belief that large pile of goods displayed in the market place leads the customer to buy more, it has become imminent for the retailers to offer a large portfolio and maintain inventory for all of them. This would be possible for the retailer only through a proper inventory management system in place which makes it significant for the retailer to adopt a replenishment model in line with their supply chain strategies (Uthayakumar and Geetha, 2009). This section would therefore try to describe the replenishment policies that are being followed by Ellos AB for managing its inventory.

PRESENT REPLENISHMENT SYSTEM

Ellos AB doesn’t have a standardized replenishment system for its product portfolio. Rather, its inventory is managed with the help of the system support ‘Tell Us’. The buyer uses the system support to extract the values from the Ellos AB historical sales data base which is used to formulate the forecasts for the coming seasons. This forecast value is then combined with the inventory details at Ellos AB warehouse to plan the replenishment quantities and intervals. Since, there is no standard replenishment model that is being employed, a safety stock is not calculated nor maintained at the company's warehouse. This often results in a higher risk of shortages thereby compromising on the service level to the customers.

Also, the present replenishment system doesn't take into consideration the lead time of each product which tends to vary largely according to the supplier location. This has resulted in situations with a mismatch between the supply and the demand of the products. One example of such a situation is shown in the figure 16.

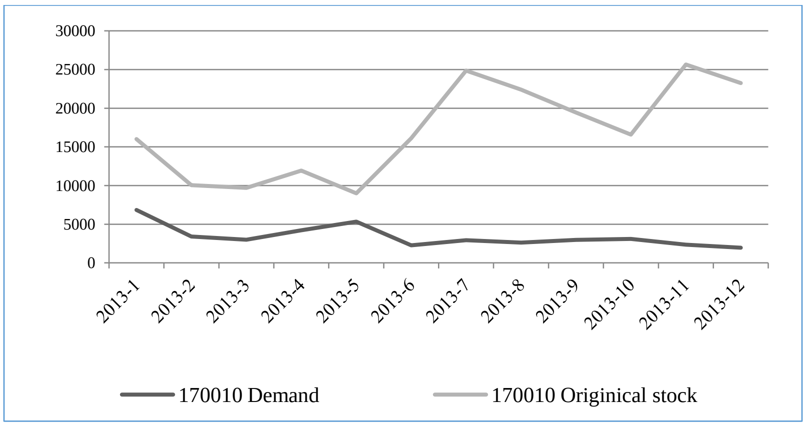

Figure 16: Stock Vs Demand graph for Item no: 170010

SUITABLE REPLENISHMENT SYSTEMS FOR NOOS PRODUCTS

There are two popular replenishment systems which are commonly employed in the industries selected according to the characteristics of the inventory systems. They are the time phased order point system and the re order point system.

Time phased replenishment system is normally employed for the items with independent demand having a discontinuous demand. The re-order point system on the other hand treats demands at all the echelons of the supply chains as independent and taking the factors like physical inventory, backorders, order released to the supplier into consideration as well.

The thesis is currently looking into the replenishment policy which would be the most appropriate for the NOOS product segment. The time phased point replenishment system is designed for products with a non-continuous demand, therefore the system becomes invalid for NOOS segment. Re-order system on the other hand is one of the most widely used replenishment system in the industry and caters to all inventory management criterion that is required to manage the inventory of a product with a stable demand. The replenishment takes into consideration a safety stock at the buyer's end reducing the risk of a shortage following an unexpected change in demand. It also accounts for the demand of the product during the transit time (which is often large in the textile industry).

RECOMMENDATIONS

The aim of the chapter is to provide Ellos AB with recommendation regarding adopting a suitable supply chain strategy for the NOOS products. The chapter would also emphasize on the potential benefits of product segmentation and adopting a suitable material planning which would be complemented by a compatible replenishment system. The chapter begins with elaborating on the benefits Ellos AB would achieve through clearly defining product segments for their entire product portfolio. Further on, elaboration on the most suitable material planning system for NOOS products at Ellos AB would be given. This would be supported by the analysis data. This would then be followed by details of the compatible replenishment system selected through the analysis phase of the thesis work. The chapter ends with a proposal of a supply chain strategy for the NOOS products (i.e. material planning system combined with the replenishment system) and the selected strategy would be justified with the analysis data formulated throughout the research work.

PRODUCT SEGMENTATION

It is highly significant for a company to have appropriate product segmentation of its product portfolio. Especially when it comes to the textile retailers who often offers large product varieties with widely varying demand characteristics, the product segmentation policies adopted becomes crucial in achieving a higher efficiency.

At Ellos AB, the entire product portfolio can be segmented into Fashion products, CFWD products and NOOS products. The benefits of product segmentation are that, it would allow the company to adapt the most suitable supply chain strategies for different segments. The segmentation would then allow Ellos AB to adopt an agile supply chain strategy for the fashion products as the product life cycle of the products tend to be small with high customer expectation. Also, it would help them maintain an optimum stock therefore resulting neither in shortages nor over stocks. In case of the CFWD products which exhibit seasonal demands, a suitable strategy would enable them to reduce the tied up capital in inventory when the demand remains low and increase the inventory during high demands without risking shortages and customer attrition.

The NOOS products which are the focal point of this thesis are expected to have stable demand with longer product life cycles. The clearly defined product segment would allow Ellos AB to strategize towards reducing the tied up capital but adapting the most suitable order, planning and control processes. It would also help in maintaining a predefined service level thus helping them attain superior customer satisfaction levels. The above enlisted are benefits Ellos AB would achieve by adopting product segmentation therefore answering the second research question as well.

Material planning system

The material planning system remains a very important aspect of achieving an efficient supply chain with optimum tied up capital. As seen, during the analysis in course of the research work, JELP models prove to be more aligned to the business model of Ellos AB. The lot for lot model and the delayed equal size shipment produce the closest result towards achieving an organized and optimized supply chain.

The delayed equal size shipments on analysis produces results which would reduce the tied up capital to the largest extend without compromising on the service levels. Of the high revenue products considered for the final analysis, delayed equal size shipments provides Ellos AB with opportunities to increase their inventory turnaround ratio. This section thus provides an insight into the question presented through the fifth research question on the most suitable material system for NOOS products.

Replenishment system

There were three replenishment policies which were considered as a plausible alternative for the present replenishment policies at Ellos AB. As the analysis dictates, the re-order point replenishment policy would prove to be the most beneficial at Ellos AB. The re-order point system takes into consideration the demand during the lead time, the average inventory level at Ellos AB and also makes sure that an order is placed only when the stock level goes below a predefined re order point. This would help Ellos AB in ensuring that the stock level never goes beyond a pre-calculated quantity thus avoiding large over stock situations. Also, the re-order point policies takes into account a safety stock calculated from the variations in historical demand data thus helping the company deal with sudden variations in demand or lead time. This would help avoid shortages and the associated usage of air freight thus maximizing the usage of the most economical mode of transport (i.e. sea route). The above elaboration is an explanation to the sixth research question on a suitable replenishment system which would complement the recommended material planning system. Also, the benefits enlisted answers the seventh research question.

Supply chain strategy for NOOS products

The significance of adopting the most suitable supply chain strategy in accordance with the product demand characteristics have been elaborated before. Therefore to conclude the recommendation at Ellos AB for optimizing the NOOS products material flow throughout the supply chain, it can be summarized that adopting a material planning system of JELP (especially delayed equal sized shipments) complemented with the re-order point replenishment policy would provide Ellos AB with the most benefits. The improvements that can be achieved through the defined supply chain strategies include a better organized material flow from the supplier to the company's warehouse. It helps both Ellos and its suppliers to plan in advance to reduce the total supply chain cost. Shortages or over stock of the items can be avoided to a large extend by maintaining an optimum stock at any point of time. This would help Ellos AB reduce their cost especially the tied up capital, the logistics costs.

The improvement that can be achieved through adapting the recommended supply chain strategy can be better understood as shown in figure 17.

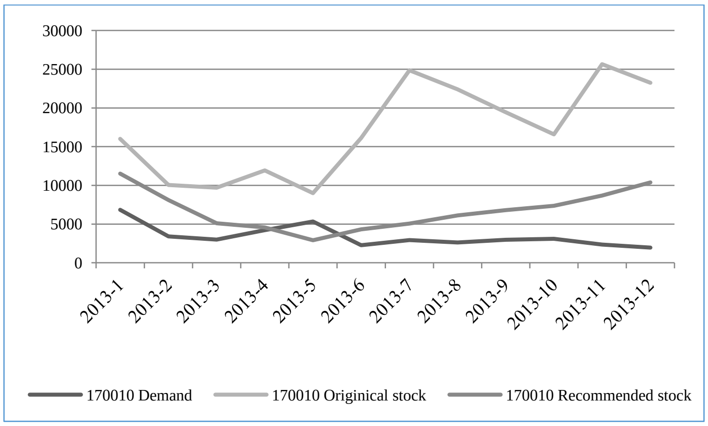

Figure 17: Comparison of recommended stock to the original stock for the demand in 2013

The above graph provides an indication of the magnitude of improvement that can be achieved through the implementation of the recommended strategy. The product is one of the highest selling NOOS product at Ellos AB and thus an improvement from the present planning system would result in considerable savings for the company. As the figure depicts, the average inventory of the product goes down considerable with the inventory turnaround ratio increasing from 2.40 to 6.08.

Also, the present replenishment policies would be replaced by a standardized system of Re-order point replenishment system with a safety stock in place. This safety stocks reduces the risk of shortages and therefore would help Ellos AB transport a major part of their NOOS products from Asian countries through sea transport. This would help the company reduce their transit considerably since the shortages leading to extensive usage of air-freight could be avoided. The estimated reduction in transit cost is represented in the figure 18.

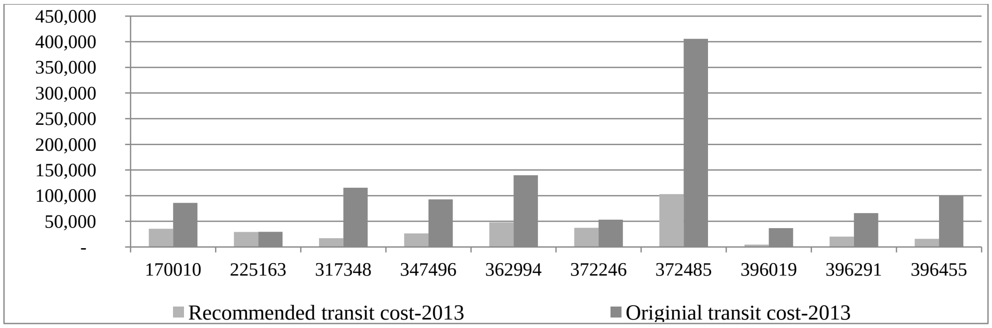

Figure 18: Reduction potential in transit cost

SENSITIVITY ANALYSIS

As mentioned in the limitation section of thesis report, obtaining all the numerical data of the entire supply chain (especially data regarding the supplier factors located in emerging countries) was difficult and time consuming. Thus calculated assumptions have been made for certain parameters with supervision from the concerned officials at Ellos AB.

A sensitivity analysis of the assumed parameter would help the company understand the possible deviations from the calculated results. This is expected to help them adjust their planning accordingly with respect to changing conditions. One of the calculated sensitivity analysis is being given below for understanding of the reader.

Table 6: Sensitivity analysis based on various production rate of the supplier

Product number	Production rate of the vendor (factor of the original demand)	Current inventory turnaround	Proposed inventory turnaround
372485	1.5	5.92	14.69
372485	2	5.92	8.97
372485	3	5.92	5.42
372485	4	5.92	4.07
372485	5	5.92	3.34

In the above mentioned example, the production rate of the supplier for the particular product was assumed as approximately 3 times the original demand. This was done with the inputs from the official coordinating the supplier relation at Ellos AB. To understand, the variation in the results, the various production rate to demand ratios have been considered and the resulting final result variations have been plotted in the below provided figure.

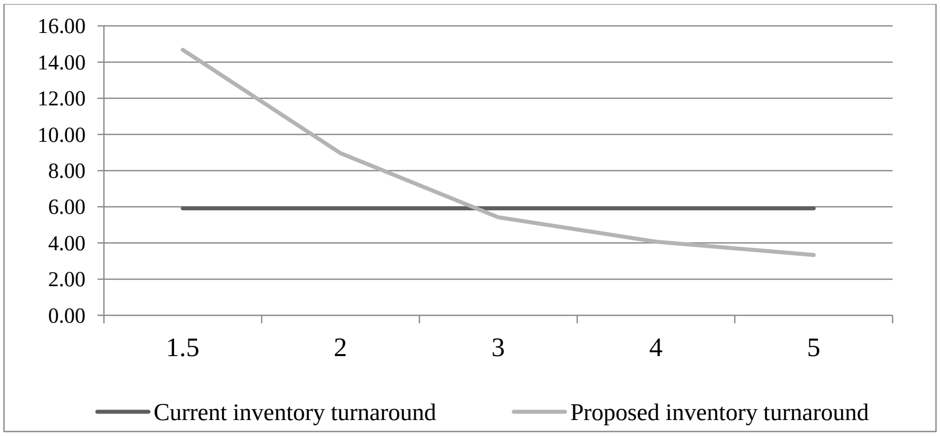

Figure 19: Sensitivity analysis on various values of production rate of the supplier

CONCLUSIONS

This chapter concludes the thesis by consolidating all the findings of the research work done. This includes the details on the present order, planning and control system which would then be followed by a recommended material planning system combined with a replenishment system. It also enlists all the benefits that would be accrued through implementing the recommended model. This section therefore would answer all the research questions thus fulfilling the purpose of the thesis work.

The first phase of the thesis work was to create a clear definition for the NOOS products. This was accomplished by product segmentation of the entire Ellos AB product portfolio. The entire products portfolio was categorized into different segments based on their demand characteristics and product life cycle. The major benefit of clearly defining various product segments includes the ability at Ellos AB to adapt different supply chain strategies for different product segments.

The segmentation was then followed by efforts to understand the present order, planning and control systems and the associated bottlenecks. This was done through extensive analysis of quantitative (historical data) and qualitative (interviews) data. The findings included details on the present material planning system assisted by the in-house built system support 'Tell Us'. It was also found out that, there wasn't any standardized replenishment system followed by Ellos AB which often resulted in shortages or overstocks. As an improvement of the present situation, a suitable order planning and control system of Delayed equal sized shipment (material planning through JELP) complemented by re-order point system (replenishment system) was evaluated.

The recommended solution was then compared to the original demand and stock data of Ellos AB in 2013 financial year so as to understand the associated benefits in details. The quantified benefits included an average increase in inventory turnaround ratio by 150-250%. The new model also accounted for a decrease in transit cost by 55% through extensive usage of sea route through a better planned chain. The model was expected to help Ellos AB decrease their risk towards shortages thus reducing the need of air-freight during stock outs thus increasing the total transportation cost. Also, with the inventory turnaround ratio increasing the tied up capital with the NOOS product segment was expected to reduce by 40%. All the benefits when combined will help their COGS for NOOS products to be reduced by 6% accruing a total of SEK 6 million in savings annually. The other benefits includes a better organized planning system therefore reducing the degree of uncertainty for the NOOS segment. The results will also help company maintain the specified service level of 95% due to reduce risks of shortage.

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