Managing upstream supply chain in order to decrease inventory level

A case study on the paper merchant Papyrus Sweden

Authors: Jérémy Bellina, Olegs Bodins, Sören Krieger and Mathilde Olivier
Supervisor: Roger Stokkedal
Examiner: Helena Forslund
Semester: Spring 2013
Course code: 4FE06E
AKNOWLEDGEMENT

First of all we would like to thank Per Olofsson, Supply Chain Director at Papyrus, for giving us the opportunity to write this master thesis in collaboration with the company and also Tony Svensson (Replenishment Planner, Processes & IT) and Pjotrs Kurtukovs (Purchasing and Logistic manager) for their dedication and willingness to help us gather the necessary empirical data in order to complete this case study.

We would like to address a special thank to our tutor Roger Stokkedal who has been very helpful and inspired us in the development of a tool to analyze activities influencing inventory level within Papyrus Sweden. Helena Forslund has also played a key role in this work and we are very thankful for all the ideas she gave us and for her constant and pertinent feedbacks.

Finally we would like to thank Arta Selimi and Therese Svensson, our opposition group, for their constructive comments and ideas for improvement. More generally we would like to thank the Business Process and Supply Chain Management class for their support all along the development of this thesis.

2013-05-29
Växjö, Sweden.

________________________
Jérémy Bellina

________________________
Sören Krieger

________________________
Olegs Bodins

________________________
Mathilde Olivier

2013-05-29
Växjö, Sweden.
SUMMARY

Business Administration, Business Process and Supply Chain Management Degree Project (master), 15 higher education points, 4FE06E, Spring 2013

Authors: Jeremy Bellina, Olegs Bodins, Soeren Krieger and Mathilde Olivier

Tutor: Roger Stokkedal

Title: Managing Upstream Supply Chain in Order to Decrease Inventory Level: A Case Study on the Paper Merchant Papyrus Sweden.

Background: The research is based on Papyrus Sweden, a paper merchant, which is facing a decrease in the demand of paper products. It was identified that inventory level reduction is now crucial for the company in order to stay in the market. Therefore, Papyrus Sweden is focused on inventory level and tied-up capital reduction in order to decrease costs and increase net profit.

Purpose: This thesis aims to analyze the current situation in Papyrus Sweden in terms of inventory level and activities related to suppliers, and prepare recommendations which could help Papyrus Sweden to reduce its inventory level.

Method: The data has been collected through interviews with managers from the supply chain department as well as through a data sample from Papyrus Sweden database given to the researchers. All data was analyzed and compared with the literature review. Data received from the database was processed and transformed in Microsoft Excel in order to make the analysis.

Results: The analysis identifies issues in material planning methods, safety stock calculation, ABC-XYZ classification and forecast calculation, on which Papyrus Sweden could act in order to decrease its inventory level. Furthermore, the researchers identify two solutions Papyrus Sweden could implement with its suppliers in order to reduce inventory level which are a Service Level Agreement and a Vendor Managed Inventory system.

Keywords: inventory level, material planning method, safety stock, ABC-XYZ classification, forecast calculation, replenishment lead time, supplier relationship, information sharing, Service Level Agreement (SLA), Vendor Managed Inventory (VMI) and Collaborative planning, forecast and replenishment system (CPFR).
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Background</td>
<td>1</td>
</tr>
<tr>
<td>1.1.1</td>
<td>The Paper Market</td>
<td>1</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Company description</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Problem Discussion</td>
<td>6</td>
</tr>
<tr>
<td>1.2.1</td>
<td>Papyrus Sweden</td>
<td>6</td>
</tr>
<tr>
<td>1.2.2</td>
<td>Inventory level reduction</td>
<td>6</td>
</tr>
<tr>
<td>1.2.3</td>
<td>Upstream Supply Chain Activities</td>
<td>7</td>
</tr>
<tr>
<td>1.3</td>
<td>Research Purpose</td>
<td>8</td>
</tr>
<tr>
<td>1.4</td>
<td>Research Questions</td>
<td>9</td>
</tr>
<tr>
<td>2.</td>
<td>Methodology</td>
<td>10</td>
</tr>
<tr>
<td>2.1</td>
<td>Scientific perspective</td>
<td>10</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Scientific perspective in theory</td>
<td>10</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Scientific perspective in this thesis</td>
<td>10</td>
</tr>
<tr>
<td>2.2</td>
<td>Scientific method – deductive/inductive</td>
<td>11</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Scientific method in theory</td>
<td>11</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Scientific method in this thesis</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Research method – quantitative/qualitative</td>
<td>12</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Research method in theory</td>
<td>12</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Research method in this thesis</td>
<td>12</td>
</tr>
<tr>
<td>2.4</td>
<td>Case study</td>
<td>13</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Case study in theory</td>
<td>13</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Case study of this thesis</td>
<td>13</td>
</tr>
<tr>
<td>2.5</td>
<td>Data collection</td>
<td>14</td>
</tr>
<tr>
<td>2.5.1</td>
<td>Data collection in theory</td>
<td>14</td>
</tr>
<tr>
<td>2.5.2</td>
<td>Data collection in this thesis</td>
<td>14</td>
</tr>
<tr>
<td>2.6</td>
<td>Scientific credibility</td>
<td>16</td>
</tr>
<tr>
<td>2.6.1</td>
<td>Validity</td>
<td>16</td>
</tr>
<tr>
<td>2.6.1.1</td>
<td>Construct validity in theory</td>
<td>16</td>
</tr>
<tr>
<td>2.6.1.2</td>
<td>Construct validity in this thesis</td>
<td>16</td>
</tr>
<tr>
<td>2.6.1.3</td>
<td>Internal validity in theory</td>
<td>17</td>
</tr>
</tbody>
</table>
2.6.1.4 Internal validity in this thesis ........................................................................................................... 17
2.6.1.5 External validity in theory ...................................................................................................................... 17
2.6.1.6 External validity in this thesis ................................................................................................................ 18

2.6.2 Reliability .................................................................................................................................................. 18
  2.6.2.1 Reliability in theory ............................................................................................................................... 18
  2.6.2.2 Reliability in this thesis ......................................................................................................................... 18

2.7 Ethical considerations ................................................................................................................................. 19
  2.7.1 Ethical considerations in theory ............................................................................................................. 19
  2.7.2 Ethical considerations in this thesis ......................................................................................................... 19

3. Theory ............................................................................................................................................................ 20
  3.1 What upstream supply chain activities within the buying company influence inventory level and what solutions within the buying company can be suggested to reduce inventory level? .................................................................................. 21
    3.1.1 Material planning methods .................................................................................................................... 22
    3.1.2 Safety stock calculation ........................................................................................................................ 24
    3.1.3 ABC-XYZ classifications of products .................................................................................................. 26
    3.1.4 Forecast calculation ............................................................................................................................... 29

  3.2 What upstream supply chain activities in collaboration with suppliers influence the buying company inventory level and what solutions in collaboration with suppliers can be suggested to reduce the buying company inventory level? ................................................................................ 33
    3.2.1 Activities in collaboration with suppliers influencing inventory level .................................................. 33
      3.2.1.1 Replenishment lead time .................................................................................................................... 33
      3.2.1.2 Supplier relationship ......................................................................................................................... 35
      3.2.1.3 Information sharing .......................................................................................................................... 35
    3.2.2 Solutions in collaboration with suppliers to decrease inventory level ............................................... 37
      3.2.2.1 SLA .................................................................................................................................................... 38
      3.2.2.2 VMI .................................................................................................................................................. 38
      3.2.2.3 CPFR ............................................................................................................................................... 40

  3.3 Analysis model ............................................................................................................................................. 41

4. Empirical chapter .............................................................................................................................................. 42
  4.1 What upstream supply chain activities within Papyrus Sweden influence inventory level? .......... 44
    4.1.1 Material planning methods .................................................................................................................... 44
    4.1.2 Safety stock calculation ........................................................................................................................ 45
    4.1.3 ABC - XYZ Classifications .................................................................................................................... 46
4.1.4. Forecasts ................................................................................................................................. 48

4.2. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden? ........................................................................................................... 49
  4.2.1. Supplier Network .................................................................................................................... 50
  4.2.2. Supplier relationship management .......................................................................................... 51

5. Data processing tool ..................................................................................................................... 56
  5.1. Processing data regarding material planning methods, safety stock calculation and ABC-XYZ classification ................................................................................................................................. 56
  5.2. Processing data regarding forecast calculation .......................................................................... 61

6. Analysis chapter ............................................................................................................................ 63
  6.1. What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level? 64
    6.1.1. Material planning methods .................................................................................................. 65
    6.1.2. Safety stock calculation ...................................................................................................... 66
    6.1.3. ABC-XYZ Classification .................................................................................................... 73
    6.1.4. Forecast calculation ............................................................................................................ 76
  6.2. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden? ........................................................................................................... 79
    6.2.1. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden? ........................................................................................................... 79
    6.2.2. What solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden? ........................................................................................................... 82
      6.2.2.1. Short term solution: Service Level Agreement (SLA) ..................................................... 82
      6.2.2.2. Long term solution: CPFR vs. VMI ............................................................................... 85

7. CONCLUSION ................................................................................................................................. 89
  7.1. What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level? 89
  7.2. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden? ........................................................................................................... 92

REFERENCES ..................................................................................................................................... 97
LIST OF FIGURES

Figure 1: Papyrus supply chain model and area of interest .......................................................... 4
Figure 2: Area of interests for research question 1 ........................................................................ 9
Figure 3: Area of interest for research question 2 ........................................................................ 9
Figure 4: Structure of the theoretical part .................................................................................... 21
Figure 5: Activities within the buying company influencing inventory level ............................. 22
Figure 6: The relationship between costs and customer service (Jonsson, 2008) ....................... 26
Figure 7: ABC classification and the Pareto curve (Wisdom IT Services India Pvt. Ltd, 2012) .... 27
Figure 8: Segmentation scheme in the context of ABC-XYZ analysis (Bohnen et al., 2011) ...... 28
Figure 9: Activities in collaboration with suppliers influencing inventory level ....................... 33
Figure 10: Analysis model .......................................................................................................... 41
Figure 11: Structure of the empirical part .................................................................................... 42
Figure 12: Activities within Papyrus Sweden influencing inventory level .................................. 44
Figure 13: ROP calculation ......................................................................................................... 44
Figure 14: Forecasting information ............................................................................................. 48
Figure 15: Activities in collaboration with suppliers influencing inventory level at Papyrus Sweden .... 49
Figure 16: Map of supplier network for Papyrus Sweden ............................................................ 50
Figure 17: Received data - inventory movements ........................................................................ 56
Figure 18: Modified data - inventory movements ...................................................................... 57
Figure 19: Modified data - inventory on daily basis ................................................................... 58
Figure 20: Received data - product master data ......................................................................... 59
Figure 21: Modified data - evaluation and database of products ............................................... 59
Figure 22: Modified data - simulation model ............................................................................. 60
Figure 23: Four-week demand per product ................................................................................ 61
Figure 24: Structure of the analytical part .................................................................................. 63
Figure 25: Activities and solutions within Papyrus Sweden to reduce inventory level ............ 64
Figure 26: Comparisons of service level performances .............................................................. 69
Figure 27: Comparison of average inventory performances ......................................................... 70
Figure 28: Differences of average inventory level in comparison to the optimal solution .......... 71
Figure 29: Service level of suppliers/ lead time .......................................................................... 71
Figure 30: Example of sales variance from the average over a year ......................................... 75
Figure 31: Activities and solutions in collaboration with suppliers to reduce inventory level .... 79
Figure 32: How to reduce inventory level within Papyrus Sweden? ......................................... 92
Figure 33: How to reduce inventory level at Papyrus Sweden in collaboration with suppliers? .... 94
Figure 34: Suggested action plan .............................................................................................. 95
LIST OF TABLES

Table 1: Swedish Paper Production 2010-2011, based on The Swedish Forest Industries - Facts and figures, 2011a .................................................................................................................................................. 1
Table 2: Swedish Paper Export 2010-2011, based on The Swedish Forest Industries - Facts and figures, 2011b ............................................................................................................................................... 2
Table 3: Papyrus data collection ............................................................................................................................................................................................................. 15
Table 4: Characteristics of Papyrus Sweden demand................................................................................................................................................. 65
Table 5: Inventory level reduction potentials ............................................................................................................................................................................. 72
Table 6 - Forecasting methods inaccuracy................................................................................................................................................................. 77
1. Introduction

In the introduction the authors present the market and company on which the master thesis is based on. It then gives an overview of issues the company is facing and introduces the subject of the paper.

1.1 Background

1.1.1 The Paper Market

Paper products are part of our everyday life. Yet over time our consumption of those products has evolved. Indeed the paper consumption per person grew in the 1980’s and 1990’s and then stagnated and fell in the 2000’s (Fairfield, 2008). Fairfield (2008) states that in the richest countries from 2000 to 2005, the paper consumption per person fell by 6%. Based on the statistics from The Swedish Forest Industries Federation, the total paper and paperboard production has experienced a 0.9% decrease between 2010 and 2011 (Table 1) (The Swedish Forest Industries - Facts and figures, 2011a).

<table>
<thead>
<tr>
<th>Paper production 1,000 tons</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Change in % 2011/2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newsprint</td>
<td>2,151</td>
<td>2,167</td>
<td>2,120</td>
<td>-2.2</td>
</tr>
<tr>
<td>Mechanical printing paper</td>
<td>1,787</td>
<td>2,019</td>
<td>2,070</td>
<td>2.5</td>
</tr>
<tr>
<td>Woodfree printing paper</td>
<td>1,273</td>
<td>1,302</td>
<td>1,277</td>
<td>-2.0</td>
</tr>
<tr>
<td>Tissue paper</td>
<td>338</td>
<td>350</td>
<td>352</td>
<td>0.7</td>
</tr>
<tr>
<td>Wrapping paper</td>
<td>999</td>
<td>1,047</td>
<td>1,013</td>
<td>-3.2</td>
</tr>
<tr>
<td>- Sack paper</td>
<td>559</td>
<td>576</td>
<td>552</td>
<td>-4.1</td>
</tr>
<tr>
<td>Corrugated material</td>
<td>1,892</td>
<td>1,902</td>
<td>1,833</td>
<td>-3.6</td>
</tr>
<tr>
<td>- Kraftliner</td>
<td>1,414</td>
<td>1,418</td>
<td>1,321</td>
<td>-6.8</td>
</tr>
<tr>
<td>Paperboard for packaging</td>
<td>2,376</td>
<td>2,511</td>
<td>2,569</td>
<td>2.3</td>
</tr>
<tr>
<td>Other paper and paperboard</td>
<td>117</td>
<td>99</td>
<td>64</td>
<td>-35.4</td>
</tr>
<tr>
<td><strong>Total paper and paperboard</strong></td>
<td><strong>10,933</strong></td>
<td><strong>11,397</strong></td>
<td><strong>11,299</strong></td>
<td><strong>-0.9</strong></td>
</tr>
</tbody>
</table>

Table 1: Swedish Paper Production 2010-2011, based on The Swedish Forest Industries - Facts and figures, 2011a
The European market has reached maturity and is now in decline while developing countries are now seen as the new frontier with great opportunities (Table 2) (The Swedish Forest Industries - Facts and figures, 2011b). This decline is directly linked to the past year changes in consumption and to the economic downturn. As the paper consumption patterns are expected to evolve even more and considering the weak European economic outlook, and the technological changes, the market is expected to follow the declining trend (The Confederation of European Paper Industries, 2010).

<table>
<thead>
<tr>
<th>Deliveries by destination 1,000 tons</th>
<th>2011 Q3</th>
<th>2010 Q3</th>
<th>Change in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU, excl. Sweden</td>
<td>1757</td>
<td>1831</td>
<td>-4.0</td>
</tr>
<tr>
<td>Germany</td>
<td>529</td>
<td>521</td>
<td>1.5</td>
</tr>
<tr>
<td>UK</td>
<td>304</td>
<td>336</td>
<td>-9.5</td>
</tr>
<tr>
<td>Italy</td>
<td>158</td>
<td>169</td>
<td>-6.8</td>
</tr>
<tr>
<td>France</td>
<td>128</td>
<td>135</td>
<td>-5.1</td>
</tr>
<tr>
<td>Denmark</td>
<td>100</td>
<td>96</td>
<td>3.9</td>
</tr>
<tr>
<td>Other Europe</td>
<td>223</td>
<td>203</td>
<td>9.5</td>
</tr>
<tr>
<td>North America</td>
<td>31</td>
<td>29</td>
<td>5.5</td>
</tr>
<tr>
<td>Latin America</td>
<td>49</td>
<td>45</td>
<td>8.9</td>
</tr>
<tr>
<td>Asia</td>
<td>357</td>
<td>319</td>
<td>11.9</td>
</tr>
<tr>
<td>China</td>
<td>79</td>
<td>75</td>
<td>4.7</td>
</tr>
<tr>
<td>Israel</td>
<td>20</td>
<td>25</td>
<td>-19.9</td>
</tr>
<tr>
<td>Taiwan</td>
<td>14</td>
<td>18</td>
<td>-20.7</td>
</tr>
<tr>
<td>Oceania</td>
<td>26</td>
<td>37</td>
<td>-29.8</td>
</tr>
<tr>
<td>Africa</td>
<td>72</td>
<td>67</td>
<td>7.8</td>
</tr>
<tr>
<td>Total Exports</td>
<td>2514</td>
<td>2531</td>
<td>-0.6</td>
</tr>
<tr>
<td>Domestic</td>
<td>280</td>
<td>286</td>
<td>-2.4</td>
</tr>
<tr>
<td>Total Deliveries</td>
<td>2794</td>
<td>2817</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

Table 2: Swedish Paper Export 2010-2011, based on The Swedish Forest Industries - Facts and figures, 2011b
There are a number of reasons that can explain this decline and the maturity achievement of this market. The technological evolution has affected the consumption of paper products. Both, in the work environment and the day-to-day life, people tend to communicate using new information technologies. The traditional paper support is in many situations not relevant any longer. Moreover, raising environmental concerns leads to the diminution of paper consumption as well as the increase cost of raw materials (Reinaud, 2004; Kallio et al., 2006).

The European paper market is in decline and this is causing major difficulties for some companies who have historically been established in the paper business (Fairfield, 2008). This is the case of Papyrus, a Swedish paper merchant who has over time established itself as one of the Continental Europe number one leaders in the Graphical and Office paper business.

1.1.2 Company description

To understand Papyrus’ activity the reader needs to picture the overall paper production business. Paper products are made by large conglomerates of small businesses specializing in a single type of paper (Philpott and Everett, 2001). Papyrus has established itself as a paper merchant, purchasing from paper mills, bringing together the manufactured products and making them available from a single source. Its historical market is the Graphical and Business Paper market. Its activity is basically centered on the supply of printing and writing paper. From office paper, envelopes, to book paper, Papyrus supplies a variety of customers: Commercial printers, Publishers, retailers, and public sectors (Papyrus group, 2012).

Indeed, Papyrus is a leading Swedish merchant of paper products, facility supplies and industrial packaging which has two main divisions: Graphical and Business Paper, and Papyrus Supplies. It was founded in 1895 after the acquisition of a paper mill located in Mölndal by the Swedish dynasty Wallenberg. Since this acquisition, the company has started operating under Papyrus name and has grown to become one of Europe’s leading merchants in paper industry. Currently, Papyrus Group has two owners: Altor (51% of shares) and Triton (49% of shares) which are investment companies focusing on developing medium sized companies (Papyrus group, 2012). Nowadays, Papyrus is well known in Europe as offering quality products and efficient supply
solutions. Today, the company is committed to its customers through high quality services and products and offers customer support services in all markets the company is operating in.

Papyrus had in 2012 a turnover of EUR 1,726 million, was represented in 22 countries across Europe and employed 2,270 persons. The company deals with more than 75,000 customers to whom it aims to offer quality products, high service levels and reliable logistics solutions all of this with its six main suppliers representing a value in purchase of 90% (Olofsson, 2013a). In order to do so, the company’s vision is based on 5 core values: Proving reliability by delivering on promises (trustworthy); Having respect for individuals, promoting cooperation and giving credit for achievements (friendly); Being professional; Responding quickly and accurately to customers (responsive); and Continuously innovating the offering to lead development in the industry (inspiring) (Papyrus group, 2012).

As Per Olofsson, (2013a) Supply Chain director at Papyrus explained, Papyrus does not produce its own paper. As it was previously stated in the description of the paper industry, companies like Papyrus only sell paper. Yet, the company selects paper products among the best in their category and carefully checks their excellence and stable properties by being continuously tested and assessed. Papyrus also aims to create long-term relationships with its suppliers based on sustainability in terms of quality, technology and the environment. Figure 1 below shows the model of Papyrus supply chain (Olofsson, 2013a).

![Figure 1: Papyrus supply chain model and area of interest](image_url)
As it is seen, the main role of Papyrus is to distribute paper to the customers. Papyrus buys paper products in bulk from its suppliers and creates value for customers through better availability, faster delivery, ability to combine products for delivery and relatively small minimum order quantity. As it is also seen on the Figure 1, Papyrus has 1st and 2nd tier suppliers which increases the overall length of lead-times and decreases Papyrus’ ability to completely control its inbound logistics.

Papyrus operates in two business areas: Graphical and Business Paper which deals with specialist distribution of paper to the graphic industry which is the historical business area of Papyrus; and Papyrus Supplies which serves corporations and public institutions with cleaning, hygiene and packaging products since 2011. Graphical and Business Paper sells an extensive range of coated and uncoated paper for professional printers; specialty papers, graphical board and digital printing papers; and office paper, envelopes and copy paper. While Papyrus Supplies is a leading supplier for products from cleaning materials, hygiene paper and catering products to industrial packaging and copy paper in the Nordic countries and deals with manufacturing industry, service companies and public sector (Olofsson, 2013a).

In order to increase sales and improve customer service Papyrus has developed “Papyrus e-services”. This service aims to make the ordering process easier for customers by integrating Papyrus e-service inside its ERP or ordering process to automate the ordering process. Papyrus e-service works 24/7 in 14 countries on a shared platform which provides market coverage that represents 95% of sales. In addition of easing the ordering process for customers, it also gives information on products, stock levels, and order tracking statistics. This tool, integrated in an ERP can then automatically transfer purchase orders, order information, and invoices to customers and offer customized solutions (Papyrus Group, 2012; Kleinschmidt, 2013; Greig, 2013).

Finally, in order to satisfy its customer needs in the best possible way, Papyrus has developed its distribution network in Europe which consists of 39 warehouses in 22 countries (Papyrus Group, 2012). To support the activity in all these warehouses, the company has to keep high level of inventories which implies high capital tied-up and inventory costs. Being on a decline market,
Papyrus and especially its Graphical and Business Paper activity is in a dangerous situation in which the company is losing money instead of gaining profits. Thus, Papyrus holds a delicate position in this declining market. Since the Graphical and Business paper market in Europe is not expected to grow, the company is now targeting new market opportunities within the continent (Olofsson, 2013a).

1.2 Problem Discussion

1.2.1 Papyrus Sweden

As stated in the introduction the paper market is a decreasing market weakened by the reduction of demand. Papyrus situation on the Swedish market is no exception as Per Olofsson (2013a), Supply Chain director at Papyrus, explained to the researchers group. What Papyrus is currently facing in Sweden reflects the situation of the European market (Fairfield, 2008), and since each country operates independently the researchers have decided to limit their study to Papyrus Sweden, Graphical and Business paper, with the aim to bring solutions that could be implemented in some other European branches of Papyrus.

Papyrus Sweden represents a set of warehouses based in Scandinavia which are supplied by three out of the six main suppliers: Stora Enso, Arctic and UPM; where each supplier provides a certain type of product.

1.2.2 Inventory level reduction

According to Barnett (1996), companies have different reasons for holding inventory, such as: being able to provide their customers with a wide range of products, matching demand uncertainties (due to imperfect forecasts), or dealing with supply price increase. Jacobs et al. (2009) add that keeping inventory is also needed to provide a safeguard in cases when the suppliers delay deliveries, increase flexibility of the production schedule and maintain independence of operation. Holding inventory can then be seen as a technique not to jeopardize customer service level and so the company’s position on a market. Thus, it is a buffer between supply and demand uncertainties which stabilizes the supply chain (Schönsleben, 2010). Yet, in
each point of view, inventory should be optimized in order to match supply and demand at lowest costs possible (Willems, 2013).

Like previously explained, Papyrus Sweden’s situation toward inventory level is critical: the required amount of paper is constantly decreasing and so are Papyrus Sweden’s revenues. Nowadays, companies and researchers are constantly finding new ways of reducing inventory level while increasing efficiency (Jonsson, 2008; Schönsleben, 2010). However, since inventories are a complex system interconnected with other related areas (like transportation and customer service), inventory levels reduction has limitations and difficulties. Since the paper market has higher competition caused by the decreasing demand, a reduction of customer service level is not an option for Papyrus Sweden and therefore, the company has decided to focus on upstream activities (Olofsson, 2013a, 2013b, and 2013c).

1.2.3 Upstream Supply Chain Activities

The flow of material, information and finances from the origin raw material to the end customer is called supply chain (Jonsson, 2008). To define an observer’s perspective, whether it is towards the sourcing or the end customer, the terms upstream and downstream are used (Simchi-Levi et al., 2008). Upstream supply chain means actors, processes and relations towards the source; while downstream supply chain means activities towards the end customer (Jonsson, 2008). In the case of Papyrus Sweden, the downstream supply chain towards its customers is defined as immutable. For this reason this research focuses on the upstream supply chain. Moreover, as Vonderembse and Tracey (2006) have identified, problematic areas linked to supplier relationship can impact inventory level such as: large minimum order quantities, long delivery frequency, long lead times, lack of product availability and insufficient information flow. This supports the researchers’ choice to focus on upstream supply chain activities.

Furthermore, the research group has decided to limit the upstream perspective to first tier suppliers since Papyrus Sweden does not interfere with other tiers suppliers (Figure 1, area of interest). As mentioned earlier, Papyrus Sweden mainly works with three main suppliers
representing 70% of purchasing value. Smaller suppliers are excluded from the research because of their little impact.

In addition, when describing Papyrus Sweden upstream supply chain activities the research group will make a distinction between activities within Papyrus Sweden and activities in collaboration with suppliers.

1.3 Research Purpose
The purpose of this research is to analyze the structure of Papyrus’ Graphical and Business paper division in Sweden in order to understand the processes and connections of upstream supply chain actors to the inventory level and create recommendations to decrease the inventory level of Papyrus in Sweden. In order to do so, the research will be divided in two distinct parts.

First, the present situation of Papyrus Sweden upstream supply chain will be analyzed and evaluated in order to highlight which activities influence inventory level in Papyrus Sweden regarding activities within Papyrus Sweden. The research group will then offer recommendations to the management team regarding internal solutions that Papyrus Sweden can implement within Papyrus while focusing on the upstream supply chain, in order to decrease the inventory level.

In the second part, the present situation of Papyrus Sweden upstream supply chain will be analyzed and evaluated in order to highlight which activities influence inventory level in Papyrus Sweden regarding activities in collaboration with its suppliers. The researchers will offer recommendations to the management team regarding external solutions that Papyrus Sweden can implement in collaboration with suppliers, to decrease the inventory level.

Thus, the focus of the research will be directed towards inventory level reduction in the Swedish warehouses of Papyrus without decreasing the service level. Therefore, the paper will consist of relevant theories and analysis of empirical data which are strongly connected to the main focus of the paper: finding internal and external solutions linked to the upstream supply chain of Papyrus Sweden in order to decrease its inventory level.
1.4 Research Questions

Thus the research questions of this paper are:

Research question 1:

- What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level?

Research question 2:

- What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden?
2. Methodology

In this chapter the researchers are going to present information needed for the reader to understand that the paper has been written in a reliable and viable way, in order to answer the two research questions stated in the introduction. By doing so, the authors will first present the scientific perspective and approach, and the research method; to then explain how data has been collected and finally focus on scientific credibility, validity, reliability and ethicality.

2.1 Scientific perspective

2.1.1 Scientific perspective in theory

The scientific perspective can be divided into two different perspectives: positivistic and hermeneutic (Remenyi et al., 1998).

The positivistic perspective concerns a perspective in which the researcher uses theory as support for his study. Indeed according to Bryman and Bell (2007), positivism states that knowledge comes from scientific methods, i.e. the theory helps the researcher building hypothesis which would be tested in practice. In a positivistic perspective, the researcher must stay objective and study the research subject from a theoretical point of view, using quantitative data, experiments and statistics (Neuman, 2003).

On the other hand, the hermeneutic perspective is a perspective in which the researcher has a subjective approach of the research subject. In this perspective the researcher uses assumptions and makes choices to build his own interpretation of a situation. This perspective is more about interpretations and understanding than just explaining a situation according to analysis. It then implies personal commitment from the research toward a phenomenon (Bryman and Bell, 2007).

2.1.2 Scientific perspective in this thesis

In this thesis, the research group uses a positivistic perspective. Indeed, the purpose of the paper being to find solutions for Papyrus Sweden to decrease its inventory level, authors of the
Methodology

The paper will base their thoughts on theoretical solutions which could help Papyrus Sweden to achieve its goals. The theory found by the authors will then be compared to empirical data coming from the company in order to find the suitable solutions to answer the research questions. In this view, the researchers clearly use an objective point of view and theoretical background to improve current Papyrus Sweden’s situation.

2.2 Scientific method – deductive/inductive

2.2.1 Scientific method in theory

Classically, there are two main scientific approaches – inductive and deductive. Inductive approach is based on empirical findings and, with the help of observation and research, goes towards the creation of theory and assumptions (Walliman, 2011; Gray, 2009). This method is relevant in exploratory studies and in studies where the researcher studies phenomenal issues which have not been studied before. In order to get reliable answers, the researcher has to prove the validity and reliability of data to prove new findings.

Deductive approach is exactly the opposite. Theoretical base is the starting point of deductive approach and the work flow moves from the theory to the practice (Gummesson, 2000; Gray, 2009; Walliman, 2011). It is the most common scientific method as the majority of topics already have theoretical frameworks which were proven in practice.

2.2.2 Scientific method in this thesis

This thesis will be based on deductive scientific method because the main purpose is to identify the key issues of inventory level reduction and find solutions which can be applied to Papyrus Sweden. The literature review will provide the researchers with the necessary theoretical base and ideas of inventory management techniques and the collaboration between buyer and suppliers. This theory will be adapted to the company taking into account specific issues of upstream supply chain, current supplier-buyer relationships and market.
2.3 Research method – quantitative/qualitative

2.3.1 Research method in theory
There are two main research methods – quantitative and qualitative. The choice of the research method depends on how the researcher wants to analyze the empirical data in order to get the answer for the research questions. Quantitative method can be characterized as mathematical, formalized, structured and more objective method of data analysis (Gray, 2009; McNeill and Chapman, 2005). It involves statistical techniques in working with numerical data and excludes subjective issues in order to get a focused answer to the specific question (Gray, 2009; Ghauri and Grønhaug, 2005).

On the other side, qualitative research method refers more to exploratory studies which do not involve hard (numerical) data. This method is less formalized and does not exclude researcher’s subjective opinion during the data analysis (McNeill and Chapman, 2005; Gray, 2009). Qualitative research method is very beneficial in cases when researchers aim to understand and explore subject in depth and not to be limited to only numerical measures (Ghauri and Grønhaug, 2005).

Gray (2009) also mentions that a quite common practice is to combine both, qualitative and quantitative methods in order to be able to answer the research questions. This type of method is called mixed and supports studies when the answers can be obtained only using both quantitative and qualitative measurements.

2.3.2 Research method in this thesis
The authors will be working with both, qualitative and quantitative data because the research is both, analytical and exploratory. Quantitative aspects of the thesis will consist of the current measurements which can be useful in order to analyze the current situation. These measurements can be lead times, errors, product volumes, etc. While qualitative data will be used in order to evaluate the supplier-buyer relationships and to find out the needs of both parties for successful collaborations.
2.4 Case study

2.4.1 Case study in theory

According to the definition of Thomas (2011, pp. 23) "case studies are analyses of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame — an object — within which the study is conducted and which the case illuminates and explicates."

Furthermore, Yin (2003) mentions that there are four reasons for choosing a case study method: first, if the research question begins with “how” or “why”; secondly, if parties in the study cannot necessarily get involved; thirdly, if the study is supported by relevant knowledge of similar phenomena; fourthly, if individual circumstances have an impact on the context of the relevant study.

Finally, Baxter and Jack (2008) count six different types of case studies: the explanatory case study, which is used if the complexity of an intervention is too high for the use of a survey or experimental strategy (Yin, 2003); the exploratory case study, which is used when the outcome of evaluated interventions is not clear and many situations have to be explored (Yin, 2003); the descriptive case study, which is used to describe a phenomenon in a real life example; a multi-case study, which enables researchers to compare between case studies. The study has to therefore follow sensitive routines in order to generate a consistent type of research (Yin, 2003); the intrinsic case studies which are used by researchers for the purpose to represent with their study similar cases, even if the focus is not on generic phenomenon or theory building (Stake, 1995); and finally the instrumental case study which is used for the purpose to support other case studies or theories. The case itself plays a secondary role (Stake, 1995).

2.4.2 Case study of this thesis

This paper aims to compare the real life practices and theoretical models. For this reason it is a descriptive case study. Even if parts with clear connection to the core problem, like inventory level or forecasting, will be written more like an explanatory case study. Indeed, because of the
complexity of these fields, the case study for these parts has to be rather explanatory than descriptive.

2.5 Data collection

2.5.1 Data collection in theory
In general, data can be divided into two categories: primary and secondary (Glass, 1976). Primary data is collected by the researcher himself; while secondary data is provided by an external source. Indeed primary data has the advantage of lowering risks of misinterpreting the data. As an advantage for secondary data, the number of data from different regions and throughout different periods can be valid for researchers. Aside from the fact, how the data has been collected, it is also important to know if the data has a qualitative or quantitative character (Flick et al., 2011). Quantitative data has the aim to compare several data to end up with a scientific underlined result. While qualitative data collection aims to an individual object and goes more deeply into the topic.

2.5.2 Data collection in this thesis
As previously described, the case study is explanatory and descriptive. Finding the right data is crucial for the quality of the research. Primary data will then be mainly used during the research. Furthermore, using measurements the case study will be based on a large amount of quantitative data. The source for that data will be provided by databases of Papyrus Sweden E3 replenishment system. However there is as well data which is valid for the research but not quantified, like information about the structure of Papyrus Sweden’s business. To gather this information, interviews have been held with managers.
Aside from information gathered during the interviews the researchers have received two different excel files with data. The first file contained inventory movements including sales and inbounds of 42 products from April 1st, 2012 to March 31st, 2013. The second file enclosed material master data containing data on the products such as suppliers, minimum order quantity, and current safety stock.

In order to use the data, adaptations had to be made to establish Papyrus Sweden’s current inventory performance. The researchers have then created a simulation model, based on sales data, lead time and minimum order quantities to compare different Re-Order Points and assess the safety stock calculation. An explanation of the simulation can be found in the data processing tool chapter (Data processing tool).

Aside from the ROP and safety stock calculation, the forecasting accuracy was an additional part of the researchers’ work, aiming to reduce inventory. To calculate the forecast accuracy, the same data received from Papyrus Sweden were used. By dividing the annual sales in 13 four-week periods, the demand per period was created. The researchers have calculated different forecasting methods based on these demand periods to finally compare the performance of these methods.
2.6 Scientific credibility

When adopting a quantitative research method with the help of surveys and the conduct of interviews, the researchers must be acknowledging that an inadequately designed and badly executed survey research will later be of small use for the analysis (Sachan and Datta, 2005). The authors describe the development of scientific credibility sections in Supply Chain Management case study methodology. The credibility of the paper is therefore linked to two issues which are validity and reliability.

2.6.1 Validity

Joppe (2000) defines a valid research as a study that truly measures what it was intended to assess, that is to say the extent to which it responds to the research questions and how close to the target’s “bull’s eye” the tools used enable the researchers to hit. For instance, formulating explicit questions during interviews will increase the overall validity of a study. When it comes to qualitative research the substance of validity is directly affected by the researchers’ perception of the notion, for instance Creswell and Miller (2000) describe how in many studies the researchers expended validity to their own set of criterion such as rigor, authenticity or trustworthiness.

2.6.1.1 Construct validity in theory

When starting a case study, the researchers need to settle on the kind of data that will be gathered and therefore need to construct and link relevant notions, concepts and premises together (Wainer and Braun, 1988). This is defined by the authors as “construct validity“. This phase will enable to secure the research path by collecting data from a variety of sources, linking them to one another and at some point creating a meaningful framework with the least room for researchers input assumptions (Yin, 2003; Golafshani, 2003).

2.6.1.2 Construct validity in this thesis

The authors will gather information from a variety of source. Per Olofsson, supply chain director will put the group in contact with operational managers within Papyrus Sweden’s supply chain. The researchers will gather, review and compare theoretical data in order to understand
theoretical practices. Review of study cases and comparison of how other branches of Papyrus adapted when facing the same situation as Papyrus Sweden will be made. Being in contact with Per Olofsson enables the group to get a strategic insight of the company performances especially since he has performance related data of each European division. Yet for political reasons, Per Olofsson could not allow the group to get in contact with paper mill suppliers. This limitation represents a major weakness especially when analyzing the buyer-supplier relationship within the supply chain; here the researcher group could unfortunately only get Papyrus Sweden’s insight. Therefore this thesis has a medium construct validity.

2.6.1.3 Internal validity in theory
After having established the link between two variables, the upcoming step consists of agreeing on causality that exists between the variables. The questions that the researcher must respond to relate to the cause and effect relationship: does A cause B? Is there another variable C that affects this causality? Lincoln and Guba (1985) describe internal validity has being achieved when change in a dependent variable can be credited to the directed variation of an independent one.

2.6.1.4 Internal validity in this thesis
The researchers group wants to preserve the high internal validity of their study by giving no room to assumptions when it comes to causalities. Yet the lack of supplier insight pushes the researchers group to make assumptions and led the researchers with a single perception. Only having Papyrus Sweden perception narrows the result of the research and leads the paper to a medium degree of internal validity.

2.6.1.5 External validity in theory
External validity refers to whether or not the results of the study can be generalized to others within a different timeframe, place, and industry or with new individuals. An ability to generalize the findings would mean that the paper has great external validity. Focusing on a single and narrow organization threaten the external validity of a study as the result will be highly dependent and customized to the organization (Yin, 2003).
2.6.1.6 External validity in this thesis
The external validity of this study is expected to be low. Indeed since the research questions focus on Papyrus Sweden situation, the finding cannot be generalized to any industry. Yet the researchers results could in some ways be adapted to other paper merchants facing a similar dilemma and to other European branches of Papyrus.

2.6.2 Reliability

2.6.2.1 Reliability in theory
According to Joppe (2000), reliability refers to the situation where it will be possible to rely on study findings over time and to which the study can be re-conducted following the same method. Therefore to be reliable a study must be both repeatable and replicable. If over time and space a measurement remains the same and that in a specific timeframe the repeated measurement remains alike then the degree of reliability is described as optimum (Kirk and Miller, 1986).

Stability when it comes to measurement is therefore essential in order to achieve similar results (Charles, 1995; Easterby-Smith et al., 2000).

2.6.2.2 Reliability in this thesis
Papyrus Sweden core activity can be described as basic; purchasing from paper mills, the value it brings to its customers relies on the storing and consolidating activity it conducts in its warehouses. Over time Papyrus Sweden has already largely reduced its activity around its core business, and the organization is not expected to simplify its business even more since the activity of the paper merchant is already very simplistic. Therefore the researchers could imagine conducting the same study in the future without revealing changes in the findings. Of course this would not be the case if suppliers change over time, so the research group projects itself in the same buyer-suppliers constellation. This thesis will thus have a high degree of reliability.
2.7 Ethical considerations

2.7.1 Ethical considerations in theory
Bryman and Bell (2007) state four main considerations that the researcher should keep in mind during the collaboration with external parties. First, the lack of informed consent. It occurs when the researcher does not give the entire information needed for the participant to properly judge whether or not he wants to collaborate. In other words this refers to the information hidden from the participant. Second, harm to participant regroups the future harm or stress that the research could bring to the participant. In order to limit this principle, the researcher should always make sure that the publication of internal data will not have negative effects on the organization or on some of its members. Third, invasion of privacy is another principle stated by the authors that measures the extent to which the researcher penetrates into the participant’s private area. Finally the ethical principle of deception means that the study group lied or gave wrong information to the participants regarding the aim of the study.

2.7.2 Ethical considerations in this thesis
When getting in contact with Per Olofsson, Supply Chain Director at Papyrus, the researchers explained in details the goal of this master thesis and specified the information they wanted to collect. Both parties agreed on the information that could get exchanged and rapidly targeted the benefits that this study could bring to each party agreeing to explore fields of improvement mentioned by the company.

This research has been conducted with a high degree of ethic. All along the research process, the researchers aimed to ensure the integrity and quality of their paper. In this thesis a clear acknowledgement has been given for articles, books, and documents used through the constant use of references.

The data collected has been pursued with the agreement of the research group company contact: Per Olofsson, Supply Chain Director at Papyrus. No distortion of information has been made and the researchers group strived to secure the data collected and agreed on not sharing sensible information that would put Papyrus Sweden in danger.
3. Theory

In this chapter the researchers will describe activities of the upstream supply chain influencing inventory level and solutions to reduce inventory level according to the existing literature review. In doing so, they will divide their research into two parts corresponding to the two research questions stated in introduction. The researchers will then first focus on activities and solutions within the buying company to reduce inventory level to later consider activities and solutions in collaboration with suppliers to decrease inventory level.

According to Schönsleben (2010), inventory is a term used to describe all the physical items that can be found in a company. Inventory management is then the activity of planning and controlling inventories (Schönsleben, 2010). Moreover, according to Willems (2013), inventory is seen differently according to which department considers it. Indeed, the sales and distribution department sees inventory as an opportunity to sell what is ready to be sold; the finance department views inventory as a liability; the supply chain department sees inventory as a buffer concealing variability of supply and demand; and the executive managers perceive inventory as an unnecessary waste and/or a necessary evil. Yet, in each point of view, inventory level should be optimized in order to match supply and demand at lowest costs possible (Willems, 2013).

Thus, as Schönsleben (2010) states, the role of inventory is to cover the total customer demand until the new arrival of products. Yet inventory level does not depend only on customer demand but also on actions taken in the entire upstream supply chain. The researchers will then divide the following part according to their two research questions: the researchers will first focus on identifying activities taken in the upstream supply chain within the buying company that influence inventory level and which solutions can be applied within the buying company in order to decrease inventory level; to then focus on identifying activities taken in collaboration with upstream partners that influence inventory level and which solutions can be applied in collaboration with suppliers in order to decrease inventory level. The following part will then follow the structure of Figure 4 below.
3.1 What upstream supply chain activities within the buying company influence inventory level and what solutions within the buying company can be suggested to reduce inventory level?

In this part, the research group has identified activities pursued within the upstream supply chain that have an effect on inventory level according to one area: activities within the company (Figure 5). The researchers will go over these activities in order to clarify their interactions with inventory level and how they can offer solutions within the buying company to decrease inventory level.
3.1.1. Material planning methods

Material planning method is the way of controlling the inventory of purchased products (Jonsson and Mattsson, 2006). In general there are two main methods: Material requirement planning (MRP) and re-order point (ROP) (Fogarty, 1991). Both methods are widely used from manufacturing and distribution companies. According to Jonsson and Mattsson (2006) MRP is mostly used for dependent demand and on the other hand ROP for independent demand.

The MRP method compares the current inventory on hand plus inventory in transit minus the upcoming demand and places the order according to the result (Chase et al., 2007). Indeed, the company has to know quite accurately how the upcoming demand will look like (Fogarty, 1991). However, in case the company knows the upcoming demand, the inventory will not react on the demand when it appears, but it will be planned proactively. As a matter of fact the average inventory level can be lower compared to a ROP method. Furthermore, it is recommended that MRP run should take place rather on daily basis than on weekly, especially if uncertainties in demand are high (Lee, 2002). However the MRP system has also further advantages apart from reducing the inventory level. Phase-outs are more easily manageable, because when the estimated demand decreases the inventory directly follows the trend (Chase et al., 2007).

On the other hand, the ROP is the trigger of the order placement. As soon as the inventory level reaches the ROP at the order time period, an order will be placed. The order time period is the point in time an order can be placed. This can happen on real-time (no actual order time
period), daily, weekly etc. The main point being that the longer the order time period is set from one another, the higher the ROP has to be (Chase et al., 2007). As an example, a product could reach the ROP on Monday while the re-order time period is on Friday. The inventory has to cover for the additional days and this has to be achieved with a higher ROP in the first place. The level of the ROP is calculated with the average daily demand times, the replenishment lead time in days plus the safety stock (safety stock calculation).

\[ ROP = \bar{d}L + \text{Safety Stock} \]

In which \( \bar{d} \) = daily demand (units), \( L \) = Replenishment lead time.

Indeed, the average daily demand has to cover the real situation. Trends for instance cannot be captured by an average (Chase et al., 2007). How the daily demand is calculated is fundamental for the ROP.

Moreover replenishment lead time is highly linked to safety stock level and re-order strategy (Osman and Demirli, 2012). Indeed, according to these authors, each stock point must deal with uncertainty of demand and of replenishment lead time. The key is then to find the optimal safety stock for which the targeted end customer service level is obtained via minimum inventory level. In order to do so, the authors suggest to implement a three-stage method in which the company must first choose the appropriate suppliers (Osman and Demili, 2010), to then build a joint strategy regarding inventory management based on forecasts and supplier’s replenishment lead time (Osman, 2011), to finally develop a safety stock policy based on demand variability and replenishment lead time uncertainty. With this new strategy, the company should be able to identify the optimal fill rate and safety stock at each stock point. After having done so, it should establish the order amounts based on deterministic assumption of demand and so the re-order point.

The two methods where compared in an empirical research from Jonsson and Mattsson (2006). The authors have researched in which cases each system is used. The finding was that the MRP is mostly used in large companies while ROP is used more frequently in small and medium sized
companies. Furthermore, the MRP method is mainly used in manufacturing companies while distribution companies chose more often ROP.

Finally, as seen earlier, the MRP method compares the inventory level with upcoming demand to later decide when to pass a replenishment order; while the ROP method triggers the order placement as soon as the inventory level reaches the ROP (Chase et al., 2007). Thus, while working with an MRP method, a company's inventory management highly depends on demand uncertainties (Lee, 2002). In order to decrease uncertainties in inventory management and so inventory level, a buying company must work on its demand uncertainties. An internal solution is then to develop a more accurate and reliable forecasting method (Jacobs et al., 2009).

On the other hand, while working with a ROP method, a company depends on replenishment lead time, as the longer the order time is, the higher the ROP is. In this situation, the remaining inventory has to cover the replenishment lead time plus the safety stock (Chase et al., 2007). Thus, according to the formula explained earlier, ROP depends on average daily demand, replenishment lead time and safety stock. The only variable on which the buying company can act in order to decrease its inventory level is then the replenishment lead time a solution is then to negotiate shorter lead time with suppliers in order to decrease the ROP.

3.1.2. Safety stock calculation

Safety stock is the inventory cover that enables to avoid stock-outs. The reason why safety stocks are defined is grounded in the uncertainty of demand and replenishment lead times (Chase et al., 2007; Simchi-Levi et al., 2008; Fogarty et al., 1991; Nahmias, 2009). An ideal situation would be a situation in which demand and replenishment lead times are precisely matching the desired requirements, in that case safety stocks would not be needed. However, in reality, the predictability of those two factors is not entirely given. Therefore the use of safety stock is a great way to insure the availability of products by preventing from the hazardous outcomes of replenishment. Yet the company has to determine the correct safety stock level for each item. Indeed, although this brings safety in terms of product availability and therefore service level, it also brings costs as it raises the overall inventory level (Nahmias, 2009).
The safety stock can be estimated in units and time (Jonsson, 2008). There are several methods to determine the safety stock and each method results in the achievement of a more or less efficient safety stock level. The key for a company is then to implement a reliable formula to reach an efficient safety stock (Simchi-Levi et al., 2008).

A common method is the simple estimation based on experience (Jonsson, 2008). This method is intensive regarding the use of manpower. This method is static and does not evolve automatically if circumstances change. Another simplifying method is a safety stock based on a percentage of lead time demand (Jonsson, 2008). The method adjusts the safety stock dynamically on the historical demand over time. However, the fluctuations inside the considered period of time are not taken into account. This leads to the fact that the method is practicable only if the deviation of demand per period is low in comparison to the average demand. A third method is based on the assumption that demand fluctuation follows the normal distribution (Chase et al., 2007). In this model, it is assumed that the lead time is constant. The formula is the variance of the demand per day multiplied by the number of days (lead time). The result of the calculation (expecting a normal distribution of demand) provides the product with an 84% chance of not running empty during the replenishment (Chase et al., 2007). In order to customize the chance of not running out of stock a z factor can be added depending on the company’s interests.

\[ \text{Safety Stock in Units} = z\sigma_L \]

In which \( z \) = Safety Stock factor and, \( \sigma_L \) = Variance of lead time demand.

In case the demand is constant and the lead time fluctuates, the formula can be adopted for this interest (Fogarty, 1991). Nevertheless, it is possible to take both variables into account and include them into a single formula (Fogarty, 1991).

\[ \text{Safety Stock} = z \sqrt{L \cdot \sigma_D^2 + \bar{d}^2 \cdot \sigma_L^2} \]

In which \( z \) = Safety Stock factor, \( \sigma_L \) = Variance of lead time, \( \bar{d} \) = daily demand (units), \( L \) = Replenishment lead time, and \( \sigma_D \) = Variance of demand.
To gain the desired service level the value of the service level factor \( z \) has to be chosen (Chase et al., 2007). This factor is exponential rising the closer it gets to a 100% (Nahmias, 2009). Since the safety stock factor is multiplied with the other values of the formulas, the whole safety stock will also raise exponentially. In practice raising the service level from 95% to 96% will not affect the inventory value as much as a raise from 96% to 97%. Figure 6 illustrates that phenomenon.

![Figure 6: The relationship between costs and customer service (Jonsson, 2008)](image)

### 3.1.3. **ABC-XYZ classifications of products**

Villefredo Pareto introduced in the 19th century what is now referred to as the Pareto effect, following a study made on the wealth distribution in Milan. The findings made by the economist revealed that 20% of people held 80% of the total wealth. Later the principle has been broaden to a variety of areas and the Pareto rule is now especially relevant when it comes to inventory management systems (Chu et al., 2008). Indeed a small number of the inventory items most of the time accounts for a great proportion of the global value of sales (Nahmias, 2009). The author describes how items groups can be grouped under A, B and C categories. With A grouping 20% of the items that stand for 80% of the annual value of sales, the B category clusters 30% of the items registering for the next 15% of sales and finally C items regroup the remaining 50%
products only contributing to 5% of sales value (Figure 7). Of course such a classification may vary, yet in practice this ABC system proved itself to be pretty accurate in terms of items division and demand value distribution (Swamidass, 2000).

Nahmias (2009) underlines the necessity of such a classification according to which greater attention should be brought to inventory levels for A items. Indeed, those are the items that will contribute to the majority of the company’s annual revenue, sophisticated forecasting methods and continuous replenishment should be favored for this category of items. While B items inventories would benefit from periodic group orders and C items, characterized by their low demand, could be handled without carrying inventories as an order to demand system would apply to this category of item.

Yet the item annual turnover is not enough, when classifying products, attention should also be brought to the products usage regularity and that’s where the XYZ analysis comes in, taking into account the variation in volume. Indeed the XYZ analysis integrates the items fluctuations in consumption in order to come up with product segment (Errasti et al., 2010). The following distinction is made: the X segment regroups item characterized by constant consumption (rather rare fluctuations in demand), Y items experience greater fluctuations in consumption

Figure 7: ABC classification and the Pareto curve (Wisdom IT Services India Pvt. Ltd, 2012)
(seasonality and trend somehow has an impact) and products from the Z segment are described has completely irregular in terms of consumption. The XYZ analysis uses the coefficient of variation (ratio of standard deviation over a period of time on average consumption) in order to characterize the demand variation (Hoppe, 2005).

In practice ABC analysis is support by the XYZ analysis and leads to the creation of a family based classification matrix:

![Segmentation scheme in the context of ABC-XYZ analysis (Bohnen et al., 2011)](image)

Items then get divided in segmented families with three different degrees of importance and are therefore given more or less attention in terms of inventory level whether they are higher or lower runners (Figure 8).

When it comes to inventory control, connecting the inventory level to the expected service levels is crucial and works as an indicator of the company’s global performance (Teunter et al., 2010). The ABC-XYZ classification implies the setting of service levels for each category of items, also called stock keeping units (SKUs). Lee (2002) confirms the need to establish service level per items category relying on his experience in providing inventory control software solution.

Yet in practice, literature does not give a unique understanding of the relationship between the ABC-XYZ classification, service levels and inventory costs. Indeed, Nahmias’ (2009)
understanding is not shared by everyone and some authors are divided when it comes to defining on which SKUs the company should give the greatest attention in terms of service level. Some authors consider that the maximum service level should be given to segment A items since those are the most profitable for the organization and to avoid shortages (Armstrong, 1985; Stock and Lambert, 2001), while researchers such as Knod and Schonberger (2001) consider that on the other hand segment C items should get maximum service level compared to other SKUs has their low value is not worth facing stock-out costs. For Teunter et al. (2010) this mismatch is the consequence of the perspective that has been chosen until now. Indeed, the inventory cost perspective has not been taken into consideration, taking in account measures aiming to reduce inventory costs. Up to now the measures considered were essentially related to criteria such as the certainty of supply, the obsolescence rate, replenishment costs or lead-times (Chen et al. 2008; Ramanathan, 2006; Zhou and Fan, 2007).

But the point on which the literature agrees is the benefit that brings an ABC-XYZ item classification when focusing on inventory level reduction. The attention brought to items should not be the same when handling inventories. Items classification is a way to prioritize products depending on the required service level the organization has set for each item. Therefore more attention will be brought to items with high service level leading to a weighting of inventory levels by SKUs and in overall a reduction of inventory levels (Nahmias, 2009).

3.1.4. Forecast calculation

Forecasting is a very important part of every business for several reasons: it helps organizations to plan their long-term objectives and strategies; the decision making process on investments have to be made according to forecasting data; financial and accounting budgeting is based on the forecasts of future sales; and the whole supply chain efficiency depends on the accuracy of sales forecasts (Nahmias, 2009).

Creating perfectly accurate forecast is almost an impossible task as the actual behavior of market is very hard to predict as well as there are many external and internal factors which can
influence the actual sales. This is why there is no universal and perfect forecasting model for any type of companies (Nahmias, 2009).

In the literature, researchers divide forecasting methods in two main categories: subjective and objective (Nahmias, 2009) (also respectively called qualitative and quantitative (Jacobs et al., 2009)). Subjective forecasting methods are based on human opinion which most commonly includes expert opinion, high-level management opinion, population surveys, etc. In most of the cases this forecasting type is implemented for the new products which are about to be introduced to the market because they do not need precise past statistical data (Nahmias, 2009; Hanke et al., 2004). Objective methods, on the other hand, are based on historical data observations and statistical actions. These methods are used to create forecasts to define level of supplies and the creation of production schedule in order to satisfy demand (Nahmias, 2009; Hanke et al., 2004). When a company uses these methods, its inventory level depends on forecast accuracy. Indeed, the more accurate the forecast is, the fewer inventory the company needs to hold (Jacobs et al., 2009).

Taking into account the situation of Papyrus Sweden, the researchers have identified that objective forecasting methods are the only applicable method in the current situation and therefore, they have decided to focus only on objective methods.

Objective methods can be divided into two main categories – time series analysis and casual approach (Jacobs et al., 2009). Time series analysis is based on the observation of historical data of series which are going to be forecasted. This approach is widely used in sales forecasting by taking into account past sales data of each product line (Nahmias, 2009). Casual approach, on the other hand, regroups forecasting methods which also analyze other series from the forecasted one. This method finds the dependence of forecast series on other factors which may influence the result. Example of this could be a macroeconomics forecasts where in order to calculate something it is necessary to take into account other macroeconomic variable which can influence the forecast area (Nahmias, 2009).
The purpose of forecasting in the current paper is to identify future sales with more accuracy. Taking into account the specifics, nature and demand trend of Papyrus Sweden products, the authors of this paper have identified that time series analysis is a more preferable approach and the specific methods of this approach will be described further.

There are two most popular and most widely used methods of time series analysis – moving average and smoothing exponential (Jacobs et al., 2009) – on which the researchers are going to focus on.

**Moving Average**

According to Jacobs et al. (2009) in cases where the demand does not have seasonal changes and rapid decline or growth trends, moving average can be a simple and efficient tool to forecast demand and reduce the random fluctuations. Simple moving average is the forecast based on average sales for the chosen period of time. The formula for simple moving average is:

\[
F_t = \frac{D_{t-1} + D_{t-2} + \cdots + D_{t-n}}{n}
\]

Where, \(F_t\) = forecast for coming period \(t\), \(n\) = number or periods to be averaged, \(D_{t-1}\) = demand for the latest past period, \(D_{t-n}\) = demand for the \(n\) period (Jacobs et al., 2009).

Selection between the number or observation periods can be chosen by company depending on the objectives of forecast and on the demand variations. Relatively small amount of observations (short-term) can create more accurate forecast if there is a small trend in the demand. But bigger amount of observations (long-term) can create more accurate forecast if the demand is relatively constant over this period of time (Jacobs et al., 2009).

**Weighted moving average**

Weighted moving average is the developed and adjusted copy of simple moving average. If in simple moving average every data in the observation period is treated equally, in weighted moving average it is possible to put more weight on specific time period in order to highlight it as more important and accurate. Usually companies put more weights on more recent time
periods in order to get more accurate results (Jacobs et al., 2009). The formula of weighted moving average is:

\[ F_t = w_1 D_{t-1} + w_2 D_{t-2} + \cdots + w_n D_{t-n} \]

Where, \( F_t \) = forecast for coming period \( t \), \( w_1, w_2, w_n \) = weights for periods 1, 2 and \( n \), respectively, \( D_{t-1}, D_{t-2}, D_{t-n} \) = demand data for periods 1 (the most recent), 2 and \( n \), respectively.

The important condition in weighted moving average must be fulfilled, where \( 0 < w < 1 \), and

\[ \sum_{i=1}^{n} w_i = 1 \]

Exponential Smoothing

According to Jacobs et al. (2009) exponential smoothing is the most commonly used technique of forecasting in companies. This method gained popularity because of its accuracy, ease to implement and due to the fact that computer storage requirements are small because it does not require large quantities of historical data.

The idea of exponential smoothing method is similar to weighted moving average, where the most recent data is considered as more important than the older. In exponential smoothing weights for older data are declining exponentially (Jacobs et al., 2009; Hanke et al., 2004). For this method only three variables are needed: a smoothing constant, the most recent forecast and the actual demand for the most recently forecasted period of time. The smoothing constant is identified by the nature of the product, demand trend and manager’s decision (Hanke et al., 2004). In the more stable demand environment smaller smoothing constant can be more appropriate and in unstable demand – larger smoothing constant will give more accurate results (Nahmias, 2009; Jacobs et al., 2009)). The general formula for exponential smoothing is:

\[ F_t = F_{t-1} + \alpha (D_{t-1} - F_{t-1}) \]

Where, \( F_t \) = Forecast for coming period, \( F_{t-1} \) = forecast for the past period, \( D_{t-1} \) = actual demand for past period, \( \alpha = \) smoothing constant, where \( 0 < \alpha \leq 1 \) (Jacobs et al., 2009).
Finally, no matter which forecast method is being used, forecast inaccuracy is a risk for any company, which negatively impact inventory level (overstock or stock-out situations) (Jacobs et al., 2009). Thus a solution to decrease inventory level is then to increase forecast accuracy, through precise formulas and data used to create forecasts.

### 3.2 What upstream supply chain activities in collaboration with suppliers influence the buying company inventory level and what solutions in collaboration with suppliers can be suggested to reduce the buying company inventory level?

In this part, the research group has identified activities pursued within the upstream supply chain that have an effect on inventory level according to one area: activities in collaboration with suppliers (Figure 9). The researchers will first go over these activities in order to clarify their interactions with inventory level. In a second time, they will interconnect the following activities in order to offer solutions in collaboration with suppliers to decrease inventory level.

![Activities IN COLLABORATION WITH SUPPLIERS influencing inventory level](image)

**Figure 9: Activities in collaboration with suppliers influencing inventory level**

#### 3.2.1. Activities in collaboration with suppliers influencing inventory level

##### 3.2.1.1 Replenishment lead time

Lead time is the time spent between the release of an order and its reception. The replenishment lead time then designs the supplier lead time (Hsu and Lee, 2009).
According to Silver and Zufferey (2011), Silver et al. (1998) and Chew et al. (2013), the total replenishment lead time can be broken down into three elements composing replenishment lead time: transit time to the supplier, time at the supplier, and transportation time to the stock point. Indeed, once the stock point notices its need of products, it has first to inform the supplier of its need (transit to the supplier), who then has to provide the product by extracting it from its stock or producing it (time at the supplier), to finally send the ordered products to the stocking point belonging to the buyer (transportation time to the stock point). These steps represent the primary components of replenishment and can experience variability, especially the two last steps of replenishment lead time (Silver and Zufferey, 2011).

Indeed, nowadays, upstream supply chains are longer and more complex than in the previous localized situations. In this context in which products cross national borders and longer distances, upstream supply chains risks are rising and particularly lead times (Kouvelis and Tang, 2012). Thus, replenishment lead times can be unstable and bring uncertainty to the upstream supply chain, which forces companies to hold inventory in order to compensate the lead time fluctuations and uncertainties (Jacobs et al., 2009). According to the literature review, some researchers (Chopra et al., 2004; Ehrhardt, 1984; Kaplan, 1970; Song, 1994) have identified the effects of uncertain replenishment lead times on inventory levels and others (Chuang, 2004; Liberatore, 1979) have focused on determining the optimal order size and ordering time while considering uncertain replenishment lead time in order to decrease its negative impact on inventory levels.

Furthermore, by shortening the supplier lead time (or replenishment lead time), a company can decrease its safety stock, reduce its stock-out loss and improve its service level. In a context in which responsive time is a competitive advantage, decreasing replenishment lead times can then allow a company to differentiate itself in the marketplace (Hsu and Lee, 2009). Thus, as it has been seen previously and accordingly to Osman and Demirli (2012), replenishment lead times are highly linked to safety stock level and re-order strategy.
3.2.1.2 Supplier relationship

According to Schönsleben (2010), a company takes into account four criteria while selecting suppliers which are: reliability, accuracy, quality and flexibility. Indeed, as Wu et al. (2013) highlight, having the right supplier can help a company reducing its purchasing costs, decrease its replenishment lead time, increase customer satisfaction and strengthen the company's competitiveness. These authors also insist on the fact that quality and reliability are the most demanded requests toward suppliers (Dickson, 1966; Weber et al., 1991) as they increase the company profitability by lowering operating costs (such as inventory carrying costs) and improve market share (Hsu et al., 2010). Thus, as Wu et al. (2013) conclude, establishing long-term relationships based on effective collaboration between suppliers and buyer becomes necessary in a highly competitive environment.

Indeed, according to Osman and Demirli (2012), one of the reasons of non reliable delivery comes from a failure in the supplying and inventory strategies, which has an effect on inventory levels. In fact, the authors consider that the primary reason of inaccurate delivery is the existence of unreliable suppliers, unable to deliver products on time. In order to improve its upstream supply chain, a company then must create relationship with reliable and coordinated partners (Osman and Demirli, 2010), to then implement a coordinated inventory system based on forecasts and supplier’s lead time (Osman, 2011) and finally being able to develop an adequate safety stock policy.

3.2.1.3 Information sharing

Achieving inventory level reduction is an aim for any merchant company, and one of the tool that is given to organizations in order to achieve this aim is information sharing. Lee et al. (2000) describe the recent efforts that industries have started in order to bring more efficiency within their supply chain and especially in the upstream supply chain. The authors underline the fact that the development of information technologies enabled the implementation of information sharing programs that aim to achieving a superior match between supply and demand. In other words, the reduction of stock-outs and the diminution of inventory costs.
Li and Lin (2006) define information sharing as the extent to which vital and necessary information gets communicated to the upstream supply chain partners. Indeed, in order to function as a unique distinct entity, upstream supply chain partners must share information on a continuous basis (Stein and Sweat, 1998) all grouped behind a single entity. The partners will then be able to appreciate the end customer’s evolving needs and respond to those changing requirements more efficiently. A common benefit of information sharing shared in literature is the reduction of the bullwhip effect. Yu et al. (2001) illustrate how by giving visibility to the suppliers on point-of-sales information, therefore sharing information with supply chain partners, the negative bullwhip effect can be minimized through the reduction of demand distortion.

Only once a company has a simplified material flow that is visible all along the supply chain, can it define its supply chain as effective and integrated (Childhouse and Towill, 2003). The performance of an upstream supply chain is commonly measured based on the degree of improvements of a variety of criteria that are reduced inventory level, shorter lead times and increased accuracy (Anderson et al., 2005). Information exchange is essential and enables to support this overall performance, yet greater information sharing does not always lead to greater performance. Barratt and Oke (2007) emphasize the idea that not all the information shared provides visibility for the organization. There is a risk of information overflow. Therefore the members of an organization should focus on valuable information, the specific type of information that provides value to upstream supply chain partners. Timeliness, quality, accuracy, and trust are some of the elements that make information valuable along with the fact that it is disposed in the proper exploitable format (Barratt and Oke 2007; Cutler et al., 2002).

In practice there are IT systems that enable moving both internal and external information along the supply chain: material requirement planning (MRP) and enterprise resource planning (ERP). While MRP systems focus on inventory management and scheduling, ERP systems regroup information coming from all sides of the organization and enable the gathering of these data under a unique system where access to valuable information can be framed.
Theory

Handfield et al. (2005) illustrate how internal information flows reach external partners. The authors emphasize the role of information flow technologies that are EDI (Electronic Data Interchange) within which the organization uses XML and ebXML to exchange secured information within supply chain members.

Barrat and Oke (2007) also underline the premises of a strategic information technology system implementation. For the authors, the partners’ relationship antecedent is the main criteria that will lead to success when implementing an information sharing tool.

3.2.2. Solutions in collaboration with suppliers to decrease inventory level

Nowadays companies and researchers are constantly finding new ways of reducing inventory while increasing upstream supply chain efficiency. Thus, to decrease inventory level, a solution would be to have reliable suppliers and shorter lead times (Osman and Demirli, 2010). According to Hajji et al. (2011), the competitive environment in which businesses evolve promotes the establishment of networks meant to accomplish goals of upstream supply chains such as inventory level reduction. In this context, coordination and partnerships are needed among organizations (Tan et al., 1998; Lee et al., 2001). In order to ease communication, some researchers suggest the implementation of cooperation and information exchange systems (Lee et al., 2001; Chan and Chan, 2010). Per Olofsson, Supply Chain Director at Papyrus advocated that Service Level Agreement (SLA) can be a solution to decrease inventory level (Olofsson, 2013a). Indeed, according to his vision, it is important to focus on the supplier-buyer relationship in order to bring stability in the upstream supply chain. Moreover, having the right suppliers, allows a company to have reliable flow, shorter lead time and so lower inventory levels (Osman and Demirli, 2012).

In this vision, implementing a long-term relationship with its suppliers appears to be a solution to decrease inventory level. By doing so, several options are available to companies. The researchers have selected three of them, which could be applied to a paper merchant: Service Level Agreement (SLA), Vendor Managed Inventory (VMI), and Collaborative planning, forecasting and replenishment (CPFR).
3.2.2.1. SLA
SLA is an agreement between a customer and a service provider which purpose is to define the performance of service and create measurements in order to control it (Parish, 1997). An SLA is then an agreement between a buyer company and its supplier which states the minimum quality of services needed to meet the business need (Hiles, 1994). Still according to Hiles (1994), it is based on negotiations between the two parties to quantify the minimum level of service acceptable via metrics based on quality of service delivered and delivered quality. Indeed, it is essential to create logical and accurate measurement system as actual performance has to be compared to target performance (Hiles, 1994). The purpose of SLA is, then, to move the responsibility of inventory management from the buyer company to their suppliers by ensuring that suppliers have to manage accurate and flexible deliveries (Parish, 1997). Also according to this author, this strategy can reduce inventory levels because there would be no need to keep huge safety stocks as the SLA partnership smoothens uncertainties and promotes fast demand responses from the suppliers. In fact, focusing on the relationship between the buyer company and the supplier by emphasizing communication and providing measures of actual performance against targets, inventory levels can be decreased and correspond more accurately to customer demand (Parish, 1997). To implement a successful SLA, it is essential to create effective and accurate Key Performance Indicators (KPI) (Parish, 1997). KPIs are widely used in businesses in order to control performance and take actions when the problem appears. It is a fast and reliable method to identify problem existence and track overall company’s performance (Parmenter, 2010). According to Parish (1997), KPIs used in SLA can include hours of service availability, response lead time, on time deliveries and reliability target. In any case, while implementing SLAs, companies must focus on measuring targets required to meet the business needs, which create compromises between the performance the buyer company expects and the service level the supplier is actually able to deliver (Parish, 1997).

3.2.2.2. VMI
Vendor Managed inventory (VMI) is an integrated solution which is based on the collaboration of buyer-supplier where the supplier is in charge of each item inventory level and more globally
on the inventory policies in order to maintain its customer inventory levels (Bowersox et al., 2011; Christopher, 2005; Jonsson, 2008). Of course this decision is based on a set of previous common agreements between both parties (Danese, 2006). With a VMI system, the buying organization shares information with its supplier more than it transfers orders (Disney and Towill, 2002), forecasts, point of sale data, inventory level; this is the information that gets communicated and which constitutes the backbone of a VMI system. Indeed, implementing VMI within an organization brings faster data transfer along the supply chain thanks to the adoption of IT tools such as EDI (Electronic Data Interchange) or web related technologies giving the buyer instant knowledge of orders and delivery status and at the same time offering the supplier an insight of inventory levels at the buyer’s warehouse (Lancioni et al., 2000).

A VMI system offers a number of benefits for the organization and its supplier: the reduction of inventory levels, the diminution of the amount of stock-outs and of their frequency, a decrease of customer demand uncertainty, greater flexibility in both production planning and distribution and the achievement of a better customer service level (Kaipia et al., 2002; Disney and Towill, 2003; Smaros et al., 2003, Holweg et al., 2005).

Achabal et al. (2000) and Disney and Towill (2003) underline the benefits of VMI when it comes to undertaking the bullwhip effect, also referred to as demand distortion. The authors explain that a VMI system enables the distortion in demand information to be reduced all the way toward the upstream supply chain and in response positively impacting service level while improving inventory quality.

Yet Simchi-Levi et al. (2000) give an insight of the difficulties of such an implementation. The authors consider that the main issue is the information sharing of confidential data reluctance that can be experienced while building a VMI framework. Another reason of VMI failure is that sometimes suppliers are not able to handle the inventory replenishment because of inaccurate forecasting and inability to predict market behavior as well as retailers can (Kuk, 2004; Angulo et al., 2004).
3.2.2.3. CPFR

Collaborative planning, forecasting and replenishment (CPFR) is a methodology that aims to integrate all the parties of the supply chain and enable to improve the overall supply chain management (Lummus and Vokurka, 1999). The CPFR tool is web-based and enables the exchange of information in the supply chain and between trading partners in order to coordinate a variety of internal activities: production, purchase planning, demand forecasting and inventory refill. CPFR basically aims to replace the traditional EDI system that has been used for over two decades within organizations (Fliedner, 2003). Indeed EDI is considered to be slow as the data is manually entered by both partners and the information is shared with periodic files sharing which delay information flow (Joachim, 1998; Cooke, 1998).

CPFR offers a number of benefits especially in terms of inventory level since it enables to reduce product inventory levels and enables to achieve a higher service level as well as improved forecast accuracy (Fliedner, 2003).

Barriers to CPFR implementation can be found; of course lack of trust between supply chain partners is the greatest issue. Indeed information is one of the most valuable assets in an organization and sharing sensible data is often perceived as a risk (Hamilton, 1994; Stedman, 1998). Hill (1999) underlines a second barrier which is the lack of internal forecast collaboration. Indeed, the author sees no purpose in collaborating with external partners if internally to the organization the demand forecast figure is not built in collaboration with every department.
3.3 Analysis model

Figure 10: Analysis model
4. Empirical chapter

This chapter will present all information collected on Papyrus Sweden in order to answer the research questions and state the current situation of Papyrus Sweden upstream supply chain and its interaction with inventory level. In order to do so, the researchers have organized information collected through interviews as in the theoretical chapter, by dividing them into two areas of upstream supply chain: activities within Papyrus and activities in collaboration with suppliers (Figure 11).

As it has been written in the introduction of this research, the European paper market is in decline (Fairfield, 2008) which causes difficulties for Papyrus Sweden on the Graphical and Office paper business. Indeed, this branch of business is losing profitability (Olofsson, 2013a) which forces Papyrus Sweden to target new market opportunities but mostly to decrease its costs. Aiming to doing so, Papyrus Sweden focuses mainly on costs linked to tied-up capital, that is to say linked to inventory level. Indeed, like previously written, Papyrus situation toward inventory, and especially Papyrus Sweden situation, is critical.
According to Per Olofsson (2013c), in April 2013, Papyrus Sweden was holding inventories representing EUR 5.6 millions, covering 78 days of cumulated days in stocks, while the European average was about 53 days in stock. Thus, the inventory turnover of Papyrus Sweden appears very low with an average of 4.7 times a year. This high inventory level cannot be explained by long replenishment lead times, as they represent in average 14 days.

Yet, Papyrus Sweden does not follow up the inventory level, neither the stock-out level. Indeed, being on a declining market, the priority of Papyrus Sweden is to offer high service level in order to stay competitive (Olofsson, 2013c). Therefore, the only knowledge regarding stock-outs comes from the sales department which informs the supply chain department whenever an order is lost due to a stock-out. However with this situation, a service level of 95 to 96% is achieved, which represents the targeted service level of Papyrus Sweden. This high inventory level also depends on the low suppliers’ reliability and long term lead times Papyrus Sweden faces. Thus, Papyrus Sweden is confronted to a lack of trust towards its suppliers regarding lead times and reliability. Furthermore, Papyrus Sweden dealing with thousands of SKUs, is also confronted to obsolescence of products which badly affects the inventory level. In addition, Papyrus Sweden inventory level is also negatively impacted by minimum order quantities and minimum delivery quantities.

Papyrus Sweden is nowadays willing to reduce its inventory level, yet the company is not willing to jeopardize its service level. Moreover, Papyrus Sweden is not able to determine a targeted inventory level it would like to achieve, the priority stated by Per Olofsson in this situation is then to focus on the upstream supply chain and especially the supplier relationship in order to shorten lead times and increase suppliers’ reliability (Olofsson, 2013c).
4.1. What upstream supply chain activities within Papyrus Sweden influence inventory level?

Figure 12: Activities within Papyrus Sweden influencing inventory level

4.1.1. Material planning methods

Papyrus is using a Reorder-Point (ROP) method for all of its Swedish stocks calculated as follow (Figure 13).

As the researchers will explain in the following part (4.1.2 Safety stock calculation), the safety stock calculation is unknown. Yet the factors affecting it are the one mentioned above in Figure...
13. Thus, the researchers have found out that the average daily demand relies on the upcoming four-week forecast period. By dividing the demand by the working days of that period the daily average demand is gathered.

Therefore, when the inventory level sinks under the ROP and order cycle point has been reached, a purchase order is created. The system checks the inventory levels on a daily basis. As soon as the order cycle point has been reached the system combines all products which are under the ROP in order to create an order. Indeed, each product has a standard order quantity which is the minimum order quantity previously negotiated with the suppliers below which a replenishment order cannot be launched. However, aside the minimum order quantity, the minimum delivery quantity is taken into account. Indeed, today the suppliers only deliver full truckloads. That means that a shipment from the supplier only takes place if a certain utilization of the transports is reached. Since the created purchase order rarely fills the capacity of the transport unit ideally (full truckload), the purchase order is adjusted manually. That means concretely that orders for products which have not reached the ROP yet are placed or that the order quantity of products which are already on the purchase order, will be increased in order to have full truckload. This has an effect on inventory level as it pushes Papyrus Sweden to order more than needed.

4.1.2. Safety stock calculation

The safety stock is directly calculated by E3 (Papyrus’ replenishment system since 2000) and although Papyrus Sweden knows how to affect the variable taken into account in the safety stock calculation, the formula in itself is a mystery for the users. Indeed, during our interview, Tony Svensson (2013) revealed to the researchers group that Papyrus Sweden does not know the formula for the safety stock calculation. This situation makes it difficult for Papyrus Sweden to judge whether or not the safety stock level for each item range is calculated according to the items rollout frequency.

Papyrus Sweden is aware of the several factors that participate in the definition of the safety stock calculation, therefore Papyrus Sweden is able to somehow affect the safety stock level.
Indeed as Tony Svensson (2013) highlighted, the service level targeted for each article from the purchaser, the average standard deviation of daily demand and the lead time variation are three factors taken into account for the safety stock calculation that Papyrus Sweden has identified. In addition, the researchers have determined that the safety stock calculation also has to take into account the maximum order cycle time, the lead time and the average daily demand (Figure 13). Therefore, for each item a safety stock is defined accordingly to Papyrus Sweden’s desired performance.

According to Tony Svensson (2013), an upcoming new release of the E3 replenishment system will give operators the opportunity to change the safety stock type. Yet it is not known so far what types of safety stock calculations will be available and the date of the release is not yet settled.

Finally, the safety stock is determined for each SKU depending on an ABC classification and its targeted service level (4.1.3 ABC - XYZ Classifications). According to the sample the researchers have received, nearly all the products (41 out of 42) have a service level factor of 96%. Indeed, due to the ABCD classification Papyrus Sweden has defined 13 out of the 42 products from the sample as B products which represent 96% of targeted service level. The rest is unclassified and for this reason defined with a target service level factor of 96%.

4.1.3. ABC - XYZ Classifications

When it comes to product classification in terms of service level, Papyrus does not set common definition or practice that needs to be followed by all of European Papyrus entities. In practice, service level classification is managed locally. Therefore each country fixes its own set of rules and processes. Papyrus Sweden follows the same rules as Denmark and Norway; they use E3 as replenishment system in comparison to other markets which use SAP as replenishment system for instance.

Papyrus Sweden follows the concept of ABC classification, giving a different service level to item groups (SKUs) according to the product availability requirements. That way each item sold by Papyrus Sweden is registered in E3 and the company defines item groups, product ranges which
will be used for the classification according to sales volume of each item and depending on how strategic the brand is for Papyrus Sweden. Indeed, following the ABC items classification, products should be classified depending on the value they bring to the company and therefore products with the greatest margin get prioritized and stocked in bigger quantities to insure availability.

Papyrus Sweden divides its products in A, B, C and D categories fixing for every item range the following service level targets: \( A = 98\% \); \( B = 96\% \); \( C = 92\% \); and \( D = 85\% \).

The service level of each product is set locally by the Marketing and Supply department and the results are periodically analyzed and compared to targets. Indeed the Head of Marketing and Supply proceeds to the classification of articles every 3 to 6 months with replenishment updating the product within E3. In practice Papyrus Sweden also pays attention to customers, its ABC classification in some ways also apply to customer type, for instance Papyrus Sweden applies a minimum pallets stock system for its important customers to be sure that the company will always be able to respond to their orders whatever the product range is.

The E3 system provides Papyrus Sweden with accurate item demand forecasts and recommended orders thanks to the analysis made of the service-level. The tool is used to bring the classification into a safety stock calculation.

The use of product classification is of great help for Papyrus Sweden since it enables the purchasing team to prioritize products and ensure the sales department that the correct articles are available in stock in the right quantities. Yet one of the inconvenient is fact that E3 is not connected to SAP, therefore this product classification is not completed under SAP. This is a need for improvement according to Per Olofsson, who understands the need for an update that would integrate within SAP this item classification. This would make the classification data available internally to all the members of the organization.

Finally, according to the researcher group knowledge of Papyrus Sweden, the company does not use any XYZ classification to differentiate products with high and low frequency.
4.1.4. Forecasts

In order to support a good customer service level and accurate deliveries, suppliers require from Papyrus Sweden an accurate forecasting. To set the manufacturing schedule and meet the demand, Papyrus Sweden’s suppliers rely on four-week period (month) forecasting, which is considered as the most accurate. In order to explain the forecasting activity, the Figure 14 below was created:

![Forecasting information](image)

**Figure 14: Forecasting information**

In the beginning of Month 1 Papyrus sends the 3-month forecast to its suppliers. The forecast for Month 2 is considered as fixed and the most accurate one on which the deliveries will be based. Forecast for Month 3 is less accurate and is subject to changes, so it is flexible and given to suppliers in order to support a slightly longer planning period. Forecast for Month 4 is approximate and is free to change over the time.

In order to calculate forecast Papyrus Sweden uses three main variables which are previous forecast, actual sales and weighting variable. The forecasting formula is as followed:

\[ F_i = (1 - \alpha) * F_{i-1} + \alpha * S \]

Where, \( F_i \) = new forecast; \( F_{i-1} \) = forecast for the last period, \( S \) = actual sales for the last period, and \( \alpha \) = weighting variable which is \( 0 < \alpha < 1 \). Here, weighting variable is individual for every Papyrus Sweden’s product and depends on the stability of the time series and product seasonality. It is also important to note that the results of forecast calculation are then adjusted manually in order to get the final forecast. Manual adjustment is based on promotions of the product and feedback from sales department.
Furthermore, forecasting accuracy is a very important issue for both, Papyrus Sweden and its suppliers. In order to satisfy Papyrus Sweden’s requirements, suppliers state that the forecasting inaccuracy should not be more than 5%. Only under this condition suppliers agree to guarantee precise deliveries and accurate replenishment lead time.

In order to calculate forecasting accuracy Papyrus uses two main methods. First and main method represents the comparison between forecasted demand and quantity of goods ordered by Papyrus Sweden. In other words, it calculates the difference between forecasted and actual demand. The second method calculates the difference between forecasted demand and confirmed orders from the suppliers. This forecasting accuracy is more valuable for Papyrus Sweden than for its suppliers because it shows the flexibility and the capacity limitations of the suppliers.

4.2. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden?

![Activities in collaboration with suppliers influencing inventory level at Papyrus Sweden](Figure 15: Activities in collaboration with suppliers influencing inventory level at Papyrus Sweden)
4.2.1. Supplier Network

Papyrus Sweden Graphical and Business paper unit is supplied by three main suppliers dispatched on three countries: Finland, Sweden and Germany (Figure 16). The company’s main warehouses are located in Mölndal and Holsbybrunn.

Papyrus Sweden biggest supplier is Stora Enso with two paper mills, one in Oulu (Finland) supplying woodfree coated paper (CWF) and one in Nymölla (Sweden) supplying a range of uncoated office paper. Arctic, another main supplier, is a Sweden based paper mill with production facilities in Munkedal and Grycksbo. Finally Papyrus Sweden gets supplied by UPM which has a paper mill in Dörpen (Germany) also supplying woodfree coated and uncoated products to both of Papyrus Sweden warehouses.

Figure 16: Map of supplier network for Papyrus Sweden
This supplier network has a direct impact on the company’s supplier relationship management. Its three main suppliers that account for 70% of the purchasing value being located across northern Europe have an effect on delivery lead times. This is according to Per Olofsson (2013a) one of today’s main issue. Indeed Papyrus Sweden suffers from long delivery lead times but what causes a problem according to the Supply Chain director are the great fluctuations that occur in those lead times. This could be resumed as a lack of reliability experienced by Papyrus Sweden toward some of its suppliers. This situation has a great impact on the way Papyrus Sweden manages inventory levels as it pushes the company to take extra caution when filling inventories to make sure none of its items will suffer from stock-outs because one of its suppliers would not have been able to deliver the items in due time.

Therefore for Papyrus Sweden this lack of supplier reliability engenders the acquisition of greater safety stocks and results in higher inventory level. Papyrus Sweden believes that the implementation of a service level agreement (SLA) toward its suppliers would enable to reduce lead times and force the suppliers to stick to Papyrus Sweden expectancies.

4.2.2. Supplier relationship management...

... in Papyrus Sweden

Papyrus Sweden considers its relationship with its three main suppliers as a win-win situation in which both parties are dependent from one another. Papyrus Sweden depends on its main suppliers which, as it has been said earlier, represent 70% of the volume of sales (Olofsson, 2013e). Yet, according to Per Olofsson, Papyrus Sweden is adding value to its suppliers too by ordering large volumes, shipping them all over Europe and giving them access to many customers (Olofsson, 2013a).

In the previous situation in which the paper market was a healthy market, Papyrus Sweden and its suppliers have grown together. Yet, being on a declining market, Papyrus Sweden is motivated to work with its suppliers in order to decrease costs in the upstream supply chain, especially the ones linked to tied-up capital, i.e. the inventory level in Papyrus Sweden’ case (Olofsson, 2013a). Indeed, according to Per Olofsson, the main target of Papyrus Sweden is to decrease days in
stock without jeopardizing customer service level. In order to do so, Papyrus Sweden wants to have shorter lead times and reliability from suppliers (Olofsson, 2013c). However, even if Papyrus Sweden has been working with the same main suppliers for many years, their relationships are only based on prices negotiations and commercial aspects.

That is why Papyrus Sweden aims to develop close relationships with its three main suppliers to create collaboration and bring stability in the upstream supply chain. Indeed, according to Per Olofsson (2013b), stability should be brought in the upstream supply chain via long term relationships and capacity commitment. Such collaboration would lead to better production planning on the suppliers’ side and a decrease in costs, especially if Papyrus Sweden provides its suppliers with accurate forecasts. Moreover, having long term capacities, stability in the upstream supply chain could also bring stability in delivery reliability, such as it could shorten lead times, decrease minimum order quantity and minimum delivery quantity, and so inventory level (Olofsson, 2013b).

Finally, in order to exchange information, Papyrus Sweden and its suppliers have a shared EDI on which the majority of the flow managed by the main suppliers goes. Yet, for now the only information shared concerns purchase order, purchase order confirmation, order confirmation and invoicing. No data about inventory level, replenishment or production capacity is exchanged.

... in other European branches of Papyrus

Papyrus Europe, which includes Papyrus Sweden, uses a reporting system which assesses supplier performance by evaluating delivery time and delivery reliability through Key Performance Indicators (KPIs) (Olofsson, 2013a). Delivery time is divided into several calculations. Indeed, Papyrus Europe first evaluates the first requested time with a variation of +/- 1 day according to the following formula: number of order lines delivered +/- 1 day from requested date divided by the total number of fully delivered order lines, in total, by country and by mill. It then calculates the first confirmed time vs. the actual delivery time with the following formula: number of order lines with +/- 1 day of variation with the confirmed date divided by
the total number of fully delivered order lines, in total, by country and by mill. To finally assess the last confirmed delivery time, just before the dispatching, and the actual lead time. This reporting tool is used in all European branches of Papyrus, yet some local entities have started implementing collaborative agreements with their suppliers in order to increase upstream supply chain stability, suppliers’ reliability and decrease inventory level.

Indeed since 2012, Papyrus Germany has begun to implement a Service Level Agreement (SLA) with its six main suppliers. This SLA has been based on the previous reporting tool described earlier and evaluates agreed replenishment lead times (per SKU), delivery reliability, minimum order quantity (per SKU) and minimum delivery quantity (as full truckloads are an issue) (Olofsson, 2013a). While implementing this agreement with its main suppliers, Papyrus Germany has decided to base its measurement on three main criteria: delivery reliability, delivery volume and replenishment lead times.

The first step before implementing a SLA was then to identify Papyrus Germany’s and its suppliers’ expectations. Thus, as seen earlier, Papyrus Germany aimed to create stability in its supply chain via strong relationships with its customers and suppliers reliability. In order to do so, Papyrus Germany top managers considered SLA as a solution in order to frame the supplier-buyer relationship, harmonize the flows and decrease inventory level (Olofsson, 2013b). On the other side, the suppliers were expecting not to increase their costs and to receive accurate forecasts in order to respond to Papyrus Germany needs the optimal way.

In order to do so, Papyrus Germany has begun to implement an SLA with its six main suppliers (Olofsson, 2013b). Since 2012, they extend it to other markets to actually cover Germany to later reach other branches such as Papyrus Sweden. As seen earlier, this agreement is mostly based on reliability and short lead times. Reliability is then being measured via delivery reliability and delivery accuracy; the main expectation being to have 90% of deliveries on time (+/- 1 day) (in the future, targeting 100%).

The first step of the implementation was to state a fixed lead time for each SKU. In a second time, Papyrus Germany has implemented KPIs to measure actual lead time down to mill level,
from order date to actual inbound date; weekly delivery reliability based on agreement previously discussed; lead time variances and stock level (days in stock). Those KPIs are being measured by mill level but as those mills are using different templates, Papyrus Germany is not yet able to collect correct figures on each mill level. Thus, the SLA now focuses on measuring KPIs at the suppliers and/or country levels. All suppliers are then assessed on same parameters regarding delivery accuracy, reliability and lead time in order to follow the trends.

These calculations are followed up on both sides. Indeed, once Papyrus Germany gets the results of the KPIs, reports are being sent to each supplier on a monthly basis. Results are then being analyzed monthly during a meeting with the suppliers in which participants identify and solve problems linked to product delivery, delivery reliability and lead time; and prepare a production capacity overview report for 12 months after having reviewed the report against targets. Supplier performance is also being analyzed on a weekly basis through teleconferences with suppliers and on a daily basis at the operational level. Finally, a quarterly meeting takes place with every supplier in order to discuss eventual changes in SLA as the process is new and still in-progress.

As the researchers can conclude from this part, Papyrus Germany is leading the implementation of changes in it upstream supply chain in order to decrease its inventory levels with the help of its suppliers. In doing so, its suppliers have accepted to respect conditions stated in the SLA, yet they have the right not to follow these rules if Papyrus Germany does not provide accurate forecasts. Indeed, Papyrus Germany has the obligation to provide accurate forecasts on country level every month to each supplier. The supplier performance can be assessed regarding delivery reliability (on time delivery) only if the forecast accuracy is the expected one (95% accuracy).

Moreover, in fall 2009, Papyrus also has started implementing a Vendor Managed inventory (VMI) in Switzerland, which is now quite developed but still evolving, as it is considered as a continuous improvement program (Olofsson, 2013e). This VMI has been developed on fast mover products (high runners) with standard variations and top sale products according to the ABC classification and XYZ principles. Indeed, products being replenished and delivered according to VMI are AX, AY, BX and BY products (Figure 8, p28). To be more accurate, this VMI
now runs 136 SKUs, representing 2/3 of the volume of sales in Switzerland; while the left third, slow mover products (low runners), are being delivered according to a normal delivery procedure.

This VMI project was a supplier initiative. Indeed the supplier was already using such a system with other customers and had the ability to implement such a system with Papyrus Switzerland. Furthermore, this process has been developed in an open and honest environment in which both parties agreed to share all information needed. The project has been handled only by supply chain actors. Thus, no commercial discussion has taken place while launching the VMI. Indeed, this project only aimed at optimizing the upstream supply chain and was based on full transparency of both sides (Olofsson, 2013e). This situation has been possible due to the fact that the relationship between both parties was already a long-term relationship based on trust.

In this VMI system, the only data shared through the EDI concerns sales figures per SKU and inventory level per SKU. In addition, weekly telephone conferences are organized to discuss input regarding exceptional happenings. Yet, no data concerning forecast on SKU level is exchanged.

This initiative has brought advantages on both sides: Papyrus Switzerland has been able to decrease its stock keeping value by 60% thanks to the implementation of VMI; while suppliers have experienced savings in terms of travel shifting (50%). The implementation of VMI has certainly brought more benefits to Papyrus Switzerland than to its suppliers, yet, by doing so suppliers have insured customer loyalty from Papyrus Switzerland (Olofsson, 2013e).

Another advantage for Papyrus Switzerland in terms of inventory level has been the decrease in days in demand. Indeed, before the implementation of VMI, the average days in demand were from 16 to 20 days (with a variance which could go up to 36 days); while after the implementation of VMI, the average days in demand is 10 to 11 days. Yet, Papyrus Switzerland does not yet reach its targeted day in demand inventory turnover which is of 7 days for products being replenished with the VMI system. Moreover, lead times have also been impacted. Before the implementation of VMI, they were subject to high fluctuations, which is not anymore a problem for Papyrus Switzerland. Thus, safety stock has been reduced as the situation is more stable and reliability toward suppliers has increased.
5. Data processing tool

In this chapter the researchers will explain how they processed data received from Papyrus Sweden and how they prepared data for the analysis in order to answer research question 1. This chapter will be divided into two parts: one part focusing on data used to analyze material planning methods, safety stock calculation and ABC-XYZ classification via a simulation tool; and a second part dealing with forecast calculation.

5.1. Processing data regarding material planning methods, safety stock calculation and ABC-XYZ classification

In order to evaluate Papyrus Sweden's current inventory performance, the firm has provided the researchers with data on 42 products. Figure 17 shows inventory movements the researchers have received on the 2\textsuperscript{nd} of May, 2013. Sales and inbounds were given from the 01.04.2012 to 31.03.2013, as well as the inventory level from the first and last day of this period.

![Figure 17: Received data - inventory movements](image)
In order to prepare data for the analysis, the researchers needed to change the structure of the data and make additional calculations. Figure 18 illustrates those changes.

![Figure 18: Modified data - inventory movements](image)

The product number (Matnr.) was added to simplify further calculation. Each row then had the same parameter (so called primary key) – 123456. In addition a combination had to be made between the product number and the date in order to give a unique identification number for each order line. The first step was to express the date as a number and secondly to link the product number with the date (expressed as number). The path of this process is shown in purple in Figure 18.

Another calculation needed was the current inventory level. In order to obtain it, the researchers have calculated the beginning inventory level plus/minus the sales/inbound movement over the given period.

Later, to be able to calculate the average inventory level, number of stock outs and lost sales, the inventory had to be given on a daily basis. Yet, according to data received, the inventory level was given only at the date on which inventory movement took place. To obtain inventory level on daily basis, the first step was to prepare the product number, date (all days of the period), the
date as number and the combination of product number and date number. In addition, sales and inbounds were summed up to get inventory movement on daily basis. This is illustrated in Figure 18 and Figure 19. For instance, on the 10.04.2012, there is one sale and one inbound (Figure 18). However, only the difference is given in Figure 19. The inventory level is then calculated based on the inventory level of the previous day and the inventory movement.

Aside from the inventory movements product master data was given by Papyrus Sweden (see Figure 20). This data was important for evaluating the performance of Papyrus Sweden’s current inventory level. Since products have different conditions like the minimum order quantity and lead times this information had to be given to interpret the results (like the average inventory).
To present an overview of data to the managers of Papyrus Sweden, the data was combined in a table which was based on the product number (see Figure 21). This transformation made it possible to identify products with low performance in terms of inventory days and stock outs. Furthermore a standard formula calculating the safety stock was added. This formula was used in the simulation described in the following paragraph.

Figure 21: Modified data - evaluation and database of products

**Goals:**
- Allocate the average inventory level
- Calculate days of inventory
- Count number of stock-outs
- Create own ABC model
- Calculate lost sales
- Calculate safety stock
- Calculate current service level

**Formula used:**
- =VLOOKUP()
- =SUMIF()
- =COUNTIF()
- =AVERAGE()
- =STDEV()
- =MIN()
- =SQRT( )

**Figure 20: Received data - product master data**

Received: 12.05.2013
After processing the data, the researchers were able to build a simulation model (Figure 22) which purpose was to show the potential improvement areas and calculate alternatives for Papyrus Sweden’s inventory level.

The simulation model contains three main areas. First, changeable parameters (outlined in blue) which can be changed by the operator. These parameters can be for instance the lead time and the order quantity and were given by Papyrus Sweden via the product master data, yet the operator can change them in order to evaluate their impact on inventory level. The second area is the calculation (on the bottom of Figure 22). The calculation relies on the actual sales data of Papyrus Sweden under the changeable parameters previously explained. The cells are linked to one another and create a virtual inventory level. All changeable parameters are taken into
account in the calculation. Finally, the third area represents the results of the simulation (in yellow in Figure 22).

5.2. Processing data regarding forecast calculation

In order to prepare data received from Papyrus Sweden for the forecasting methods analysis, the researchers group calculated the past four-week demand for each product for the whole year. Four-week demand represents the sum of demand for 28 days and therefore the researchers got 13 four-week periods. The Figure 23 below represents the results of this activity.

![Figure 23: Four-week demand per product](image)

The next step was to calculate forecasts using each forecasting method and the demand for 4-weeks.

First the researchers have tested the simple moving average formula. This forecast calculation is based on three 4-week periods. For instance, in order to calculate forecast for week 4 it is necessary to calculate the average for three past periods. The researchers decided to base this forecast on three past periods as the results of calculation were more accurate than when the researchers took four, five, or more time periods.

Second, the researchers have calculated forecasts using a weighted moving average formula. The technique for this type of forecast calculation is similar to simple moving average, and therefore, it is also based on three past periods. However, it is necessary to assign weights for each period so these periods can be treated differently. The researchers found these weights by using
“Solver” function in Microsoft Excel. “Solver” automatically found weights with the condition that the final forecasting accuracy is the highest.

Third, the researchers have tested an exponential smoothing formula. This method allows calculating forecast based only on one past period's demand. Smoothing weights were found using the same principle as in weighting moving average approach.

Finally, the researchers have assessed Papyrus Sweden’s forecasting formula. This formula is very similar to exponential smoothing, and, therefore, the same approach was applied with the only difference that rearrangement of data in the formula was made in order to precisely use the Papyrus Sweden's forecasting formula.

After calculating all forecasts, the researchers had to compare the inaccuracies of each method and identify the most accurate forecasting method for Papyrus Sweden’s demand. First the researcher calculated the inaccuracy of forecast by calculating the difference between the forecasted value and the actual demand for the selected period. This number was transformed using “ABS” formula in order to show the absolute value of the number. This operation was made for the whole year and for each product. Then, in order to calculate the inaccuracy in percentage, the sum of inaccuracy for the whole year was divided by the sum of the actual demand for the same amount of four-week periods. The percentage received represents the final inaccuracy occurred during the whole year. The same procedure was made for all forecasting methods.
6. Analysis chapter

In this chapter the researchers will link theoretical knowledge and empirical data in order to illustrate Papyrus Sweden situation toward inventory level and suggest solutions to reduce inventory level. By doing so, the researchers will divide their work into two parts, answering the two research questions stated in the introduction. In a first part the researchers will focus on activities and solutions within Papyrus Sweden to reduce inventory level; to later work on activities and solutions Papyrus Sweden could develop in collaboration with its suppliers to reduce inventory level (Figure 24).

---

**Figure 24: Structure of the analytical part**
6.1. What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level?

In order to answer the first research question, the researchers have considered in the theoretical and empirical parts activities within Papyrus Sweden that could influence inventory level and in which solutions could be suggested in order to decrease inventory level at Papyrus Sweden. Thus, as the researchers have identified in the theoretical part, four factors within a buying company such as Papyrus Sweden can influence inventory level: the material planning method, the safety stock calculation, the ABC-XYZ classification and the forecast calculation. In the case of Papyrus Sweden, the authors are then going to verify this theoretical statement, following the structure described in Figure 25 below.

![Figure 25: Activities and solutions within Papyrus Sweden to reduce inventory level](image)

The upcoming part will be based on data which Papyrus Sweden has extracted out of both its SAP and E3 replenishment system. This data includes sales in volume and inbound movements of 42 products over one year (from 01.04.2012 to 31.03.2013) and the current stock level at the 01.04.2013. For all products the researchers have also received product master data such as the corresponding supplier, minimum order quantities, replenishment lead time, and items service level target. Yet the researchers did not have access to any financial data. The researchers have based their analysis on this data and have used them to extract information and calculate their assumptions and suggestions, as described in the data processing tool chapter (2.5 Data collection).
6.1.1. Material planning methods

As described in the theory chapter, there are two material planning methods (Fogarty, 1991): Material Requirement Planning (MRP) and Re-Order Point system (ROP). Papyrus Sweden is currently using a ROP method as material planning system. As it can be seen in Table 4 the requirements of Papyrus Sweden are in line with the theoretical recommended type of material planning.

<table>
<thead>
<tr>
<th>Area</th>
<th>Characteristics</th>
<th>MRP</th>
<th>ROP</th>
<th>Papyrus Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>Dependency</td>
<td>Dependent</td>
<td>Independent</td>
<td>Independent</td>
</tr>
<tr>
<td></td>
<td>Predictability</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 4: Characteristics of Papyrus Sweden demand

Indeed, the assortment of Papyrus Sweden is independent to one another. That means that a purchase of one product does not require buying another product. Usually, a MRP system is applied in production firms, in which interdependency of products is controlled by a bill of material (Jonsson and Mattsson, 2006). However this is not the case for Papyrus Sweden. Indeed, still according to Jonsson and Mattsson (2006), a merchant company usually uses a ROP method, with independent assortment. Furthermore, the predictability of demand in Papyrus Sweden is low. That means that the future demand is varying from the expected demand a lot. Traditionally, production firms which have a fixed production schedule for the upcoming weeks can rely on their assumptions, trading firms on the other hand, such as Papyrus Sweden, cannot.

Aside from the theory there are other reasonable motives why the ROP system is preferred. For instance, Papyrus Sweden has constant problems with its utilization of inbound transports, that is to say full truckloads. This requires managers to modify the purchase orders towards the suppliers in order to respect minimum delivery quantities, and optimize the truck utilization.

To sum up, Papyrus Sweden using a ROP method, which according to theory is the material planning method a merchant company is supposed to use (Jonsson and Mattsson, 2006). The researchers group can not suggest any modification for Papyrus Sweden to decrease its inventory level via a more efficient material planning method.
6.1.2. Safety stock calculation

Along this part the focus will be given on two key notions: stock-out and service level. The researchers define a stock-out situation every time the inventory level of a product reaches zero. On the other hand if the inventory is greater than zero the system does not calculate a stock-out situation. In this analysis stock-outs are measured in days. This definition is chosen because of technical reasons: the researchers do not have access to customer orders. For instance it could happen that Papyrus Sweden receives a customer order but does not have enough inventories on hand to fulfill the order. Since the researchers cannot include the number of those appearances (customer orders are not given) the definition of stock-out had to be limited to the described definition.

The second term used in this part is service level. The researchers distinguish service level targeted, given by Papyrus Sweden and service level achieved, calculated by the researchers. The service level achieved distinguishes the days where inventory is on hand (greater than zero) and stock-outs. It represents the percentage a product available on a daily basis. For example if a product has, over a period of one year (365 days) inventory on hand of 329 days and stock-outs of 36 days, the service level will be approximately 90%.

\[
\text{Service level} = \frac{\text{days inventory on hand} \times 100}{\text{days per year}} = \frac{\text{days per year} - \text{stockouts} \times 100}{\text{days per year}}
\]

\[
\text{Service level} = \frac{(329) \times 100}{(365)} = \frac{(365) - (36) \times 100}{(365)} = 90\%
\]

This part is divided into four steps in order to guide the reader along the researchers work. At first the current situation of Papyrus Sweden safety stock will be discussed. Secondly, the researchers will create several safety stock calculation methods. Thirdly, comparisons will be made between the simulated solutions and the current situation. Finally, potentials to reduce the inventory level will be pointed out and suggestions will be made.

Current situation of Papyrus Sweden safety stock

According to the researchers analysis on average the service level achieved for the 42 products is of 96%. Since the given products from Papyrus Sweden are characterized as B products (4.1.3
ABC - XYZ Classifications) or unclassified articles, the targeted service level is also of 96%. Papyrus Sweden targeted service levels meet exactly the average of the achieved service level. Nevertheless, the achieved service levels experience significant variations from 83% to 100% depending on the products. For Papyrus Sweden the wide range of service levels has a large impact on inventory carrying costs. Because the volume of products needed to cover the service level raises exponentially towards infinity the closer it gets to 100% (Nahmias, 2009; Figure 6, p26).

**Safety stock calculation methods**

According to Nahmias (2009) Papyrus Sweden will reduce its inventory level and remain at the same achieved service level by creating a solution which levels the individual service levels all towards the targeted level of 96%. In order to prove the theory of Nahmias (2009) a simulation has been built. The researchers chose to model a simulation-tool which takes into account: the origin sales data, physical inventory, theoretical inventory (inventory on hand + inventory in transit), order placement, inbound movements, ROP, lead time and minimum order quantity.

In order to fulfill the purpose of the analysis three simulations have been made for each product.

First the researchers have created a simulation which shows the optimal solution according to the targeted service level of 96% predefined by Papyrus Sweden. This method provides the optimal ROP via the targeted service level.

The second simulation provides a new alternative for Papyrus Sweden by calculating a new safety stock. Indeed, a standard safety stock formula with average daily demand, standard distribution of demand and the given lead time without variance has been used (Chase, 2007).

\[
\text{Safety Stock in Units} = z\sigma_L
\]

In which \( z \) = Safety Stock factor and, \( \sigma_L \) = Variance of lead time demand.

The researchers did not choose the safety stock formula with lead time variation (Fogarty, 1991)
Safety Stock = z \sqrt{L \sigma_{L}^2 + \overline{d} \sigma_{D}^2}

In which z = Safety Stock factor, \( \sigma_{L} \) = Variance of lead time, \( \overline{d} \) = daily demand (units), L = Replenishment lead time, and \( \sigma_{D} \) = Variance of demand.

Thus, the small variation of lead time was given as 5% and calculations have shown that the results are equal to the formula without lead time variance.

Third a simulation of 100% service level has been made to prove the validity of the simulation system. Indeed, as seen in the methodology chapter, findings have to be perceived as critical (Joppe, 2000). For that reason the researchers controlled the validity of their simulation tool in order to be sure of their results. By comparing the results of the simulation with the actual results of Papyrus Sweden it was proved that the validity was achieved.

Moreover, the researchers’ simulations aimed to capture the reality as precisely as possible. However, complexity and accessibility of data has created limitations. Therefore, the researchers are aware of the following limitations:

- The historical data from Papyrus Sweden showed that unusual high sales orders were preceded by large inbounds. In this case, the researchers have made the assumption that these unusual sales had to be known before and a purchase order was manually made. These sales are still taken into account in the simulation. The performance of the simulated numbers will be affected negatively.

- The simulation does not distinguish working days and weekends (and bank holidays). Replenishments are then faster as in the reality. The service level will therefore be influenced positively.

- The suppliers in the simulation did not have any stock -outs or delays on the replenishment. For this reason the service level will not be negatively influenced in the simulation.

- The simulation uses the average sales over the whole year, regardless if those numbers came in fact out of the future. The forecast based average demand in reality
just sees the past. However it is neither an advantage nor disadvantage, because the forecast is also influenced by information on seasonal factors.

- Some products (13 out of 42) have not enough inventory movements to create a solid model. Those products have been excluded from the simulation.
- A seasonal trend is not taken into account in the simulation. This brings an advantage for Papyrus Sweden’s inventory level and makes the simulation perform weaker.

**Comparisons between the simulated solutions and the current situation**

Figure 26 shows the performance of the service level towards Papyrus customers. The blue curve represents the current achieved service level. The fluctuation is high and most products of Papyrus Sweden provide customers with either a too low or too high service level. The standard formula, represented by the red line has also a certain fluctuation in its service level performance. However this performance is significantly closer to the optimal solution represented by the green line.

![Service level performances](image)

*Figure 26: Comparisons of service level performances*
By comparing the performances of inventory level of each simulation, (Figure 27), it can be seen that the current performance (blue line) causes many peaks. In some cases the current inventory level average even exceeds the maximum service level of 100% (purple line). Since the customer service level cannot be better than 100%, all inventories above can be considered as waste. It is notable that on the other hand the weak service levels of the current situation do not make an observable difference when it comes to the average inventory. Figure 26 and Figure 27 combined prove that theory of Nahmias (2009) is adoptable to Papyrus Sweden inventory situation. Surprisingly, the calculated safety stock with the standard method (red line) is very predictable when it comes to average demand. The standard safety stock method follows the optimal solution closely.

Figure 27: Comparison of average inventory performances

The difference between the current safety stock and the simulated standard model can be seen in Figure 28. The figure shows how much the average demand differs from the optimal solution. Despite some exceptions the current calculation has a difference towards the optimal solution than the calculated solution.
Figure 28: Differences of average inventory level in comparison to the optimal solution

Figure 29 distinguishes Papyrus Sweden’s safety stock method and the standard formula according to lead times and suppliers.
It can be seen that Papyrus Sweden has difficulties to gain a service level of 96% of products from the supplier “Arctic”. This can be a hint that “Arctic” has problems to replenish Papyrus Sweden’s inventory level and that its reliability is low. However, the researchers cannot prove this assumption as Papyrus Sweden purchase orders are not given. Another assumption which could be made is that the standard formula decreases the service level the longer lead time is. Nevertheless, this interpretation cannot be stated as proved as the number of samples is too low and a scientific statement cannot be made.

**Potentials and suggestions to reduce the inventory level of Papyrus Sweden**

In total the change of the safety stock method to the standard method (Chase, 2007) would have a major impact on Papyrus Sweden average inventory level as shown in the following Table 5.

<table>
<thead>
<tr>
<th></th>
<th>Current situation</th>
<th>Standard safety stock method</th>
<th>Simulation 96% service level</th>
<th>Simulation 100% service level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Service level</strong></td>
<td>96%</td>
<td>96%</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Average inventory (units)</strong></td>
<td>10088</td>
<td>5972</td>
<td>5612</td>
<td>12125</td>
</tr>
<tr>
<td><strong>Lost sales (units)</strong></td>
<td>2558</td>
<td>4840</td>
<td>5088</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-41%</td>
<td>-44%</td>
<td>20%</td>
<td>47%</td>
</tr>
</tbody>
</table>

*Table 5: Inventory level reduction potentials*

Indeed, Table 5 compares the different calculations made in the researchers’ simulation. The described standard safety stock method would decrease the inventory by 41% (in volume). That would bring an important contribution to Papyrus Sweden’s goal to reduce the tied up capital, i.e. inventory level. However, it has to be mentioned, that because of the different distribution of sales volume on the taken products, the number of lost sales will increase. Nevertheless, it is not possible to judge how the trade-off between lost sales and reduced inventory would look like, since prices and profit margins are unknown. Finally, the researchers suggest Papyrus Sweden to change its safety stock method to the standard method calculated as follow:
Safety Stock in Units = \( z\sigma_L \)

In which \( z \) = Safety Stock factor and, \( \sigma_L \) = Variance of lead time demand. With this formula, in case the lost sales increase more than the managers accept, the safety stock factor should be raised.

### 6.1.3. ABC-XYZ Classification

**ABC classification**

Papyrus Sweden handles its inventories according to an ABCD classification with the following service level targets: A= 98%; B= 96%; C= 92%; and D= 85%. Indeed the company makes a distinction between items according to their value of sales setting greater service level targets for items that account for most of the company’s revenue (Nahmias, 2009). The researchers group has unfortunately not been given the opportunity to go deep in the way Papyrus Sweden classifies its products following this ABCD ranking. The data sample given to the researchers group was only constituted of B products with a service level target of 96% and unclassified items which were also automatically set with a 96% service level target. Therefore the researchers could not proceed to comparisons and analysis between different SKUs. Yet the researchers group brought some attention to the unclassified items.

Per Olofsson (2013b) explained that in theory Papyrus Sweden reviews the classification of its articles every 3 to 6 months within the E3 replenishment system. Having worked with unclassified products (28 out of 42) which have been running for over a year, the researchers can say that the process of reviewing the ABC classification of Papyrus Sweden’s products is not always done on the described bases. An assumption would be that those unclassified products are “new products” that have been entered in the system since no longer then one year; therefore Papyrus Sweden cannot put those items into a classification since the period of time is too short to predict a demand pattern. For this not to be an issue in the upcoming year the researcher group suggests that every new product stays unclassified for a no longer period than one year. After this period of time each item is assigned to a category and is defined a service level target. Both will of course evolve over time according to changes in demand. Yet, judging
from our data sample, it is clear that most of those unclassified items have been running for
more than one year therefore the periodical review of the E3 system has not been made. A
suggestion would be that Papyrus Sweden goes through its unclassified items and assign them
with an ABCD classification so that the items are dealt with the appropriate service level target.
Indeed, a more accurate ABCD classification would enable the company to give the right
attention to items which have a great impact on Papyrus Sweden’s activity, especially when it
comes to defining the proper amount of stock and safety stock needed for an item in order for it
to achieve its defined service level. A suggested solution to reduce inventory levels would then
be to implement a reviewed ABCD classification among Papyrus Sweden products, stating
different services levels and being acidly reviewed every 3 to 6 months in order to better fit
customer demand.

**XYZ classification**

When processing to the analysis of the data given by Papyrus Sweden what strikes is the
variability in demand that can be seen on a number of items over a one year period. Although
the researchers group could not compare those results to previous years and distinguish if those
fluctuations in demand corresponded to trends and seasonalities, what the researchers group
could distinguish were the variations in volume that characterize some of those items. According
to Errasti et al. (2010) distinctions should be made between items according to the items’
fluctuations in consumption. Therefore an XYZ analysis is needed as the replenishment and
inventory policy of highly variable items (Z class products) will not be the same as the one for
items that are stable and for which orders come in on regular bases (X class products) (Bohnen
et al., 2011).

Papyrus Sweden does not seem to take this into consideration when classifying its items. Indeed
according to theory, frequency of demand affects the inventory level management as X products
have a constant consumption pattern and are described as fast movers (Errasti et al., 2010) and
therefore require attentive monitoring and control in order for them not to fall in stock-outs. Z
class products on the other hand, also called slow movers; require less control. Yet for Papyrus
Sweden they may cause excess inventory in terms of inventory as their consumption pattern is
hard to establish. For example they may cause the organization to stock itself with a range of items all year long although the demand for those items only occurs 3 times a year.

The researches group analysis shows how among the 42 items selected, distinctions could be made between slow and fast movers. For the sake of demonstration three representative items were taken in Figure 30. The green curve illustrates the behavior of a fast mover item, with a pretty constant demand that has a 21% variance in demand over the year, the variance being the average demand divided by standard deviation. The yellow curve corresponds to a standard item with a greater variance of 71% and finally the read curve represents a slow mover with a 108% variance in demand, therefore unstable demand characterized by flat periods with demands and sudden large orders.

![Figure 30: Example of sales variance from the average over a year](image)

A suggested solution for Papyrus Sweden would be to link its ABC classification to an XYZ analysis in order to handle those variations in demand. According to the item sample the researcher group has identifies variances going from 20 to 130%, this is not representative of all
of Papyrus Sweden’s items yet the assumption is made that X class items could regroup low variance products (0 to 50%), Y class item could regroup the medium variance items (50 to 90%) and finally the Z class item would gather item with a demand variance that is above 90%.

6.1.4. Forecast calculation

As Nahmias (2009) stated, there are no universal forecast which can be implemented for all companies, so therefore, it is important for a company to develop its own way of forecasting or adopt the existing forecasting methods which will fit to the company’s situation. In the case of Papyrus Sweden, the company has developed its own forecasting method, which, however, has some similarities with exponential smoothing described in the literature review (Jacobs et al., 2009). Both these methods use only previous month demand, previous month forecast and weighting variable. As it has been described in theory chapter, forecasting methods can be divided into two main categories: objective and subjective (Nahmias, 2009). Papyrus Sweden is using an objective method which is characterized by analysis of historical data and implementing statistical data (Nahmias, 2009). Moreover, an objective method can be divided in two main approaches: time-series and casual. It has been identified that Papyrus Sweden is using a time-series approach which relies on creating a sales forecast based on past demand data (Nahmias, 2009).

In order to test all theoretical forecasting calculation models presented in the literature review and to compare their performance with the forecasting formula Papyrus Sweden is currently using, the researchers group has first calculated the four-week demand for each article of the given data sample (historical sales data from last year). Obtaining the results, the researchers have noted that the deviation of sales is quite significant with an average deviation of 60% for all articles. Moreover, another noticeable fact is that articles which have seasonal forecasting profile have smaller deviation than articles with standard forecasting profile, respectively 50% and 64%. Therefore actual demand for seasonal products is more stable on monthly basis than demand for other non-seasonal products.
The methodology used in testing the forecasting formulas has consisted of simple usage of formulas and comparison between the data forecasted and the actual demand Papyrus Sweden faced during the forecasted period. The average forecasting distortion has been considered as the determining factor of the accuracy of forecasting formula. The distortion has been calculated by summing all four-week periods net errors (in units) divided by the demand of the same period. It is important to note that the researchers group has tested only forecasting formulas and has not taken into account the manual adjustments which Papyrus Sweden makes before getting the final forecast. The research of forecasting methods is then objective and considers only systematic forecasting formulas. In addition it is important to note that the smoothing variables were chosen individually for each article with the help of a Solver (linear programming) tool which calculated perfect smoothing average in order to get the smallest forecasting mistake possible.

The Table 6 below represents the average inaccuracy calculated from each forecasting method:

<table>
<thead>
<tr>
<th></th>
<th>Seasonal articles</th>
<th>Non-seasonal articles</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Moving Average</td>
<td>57%</td>
<td>76%</td>
<td>71%</td>
</tr>
<tr>
<td>(based on three 4-week periods)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted Moving Average</td>
<td>52%</td>
<td>71%</td>
<td>66%</td>
</tr>
<tr>
<td>(based on three 4-weeks period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exponential Smoothing</td>
<td>49%</td>
<td>64%</td>
<td>60%</td>
</tr>
<tr>
<td>Papyrus forecasting</td>
<td>49%</td>
<td>63%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table 6 - Forecasting methods inaccuracy

According to the Table 6 above, the results show that the most accurate forecasting formula for Papyrus Sweden is an exponential smoothing one or the forecasting formula the company currently uses. Indeed, the simple moving average formula shows the worst forecasting accuracy while the weighted moving average formula shows an intermediary result with better accuracy than with a simple moving average formula but still less than with an exponential smoothing
one. In addition, another noticeable fact is that the application of standard formulas which, in theory, are not supposed to be used in forecasting of seasonal products (Jacobs et al., 2009), shows the best forecasting accuracy for products which Papyrus Sweden identified as seasonal. The researchers have no information of products description, so it is impossible to identify why this phenomena occurred. Furthermore the one-year data sample received from Papyrus Sweden may not be enough to judge this phenomenon accurately.

According to formulas performances, the researchers group has identified that formulas with smoothing variables (weights) are performing better. Thus, in the case of Papyrus Sweden different time periods cannot be judged equally and decisions have to be made to weight importance of one period over another. The importance of weighting variables is caused by uncertainty in sales. For instance, taking a product P, Papyrus Sweden may have zero sales for a few periods to later face a number of sales which represents twice the average of monthly demand.

According to Per Oloffson (2013b), Papyrus Sweden forecast inaccuracy represents only 5% of purchasing orders while according to the researchers calculations forecast inaccuracy reaches 60%. In this situation, the researchers group has been unable to evaluate how Papyrus Sweden is able to decrease its forecast inaccuracy from 60% to 5%. Therefore, they have made the assumption that manual changes based on experience and human factor are responsible for this high level of forecast accuracy. Indeed, the researchers consider that the sales department has developed long term relationships with its customers which enable them to better foresee the future demand, especially linked to seasonality of the business paper market. Thus, the researchers are unable to suggest any solution to decrease inventory level via higher forecast accuracy. Yet, this high level of forecast accuracy could enable Papyrus Sweden to decrease its inventory level via higher reliability and stability in the supplier relationship.
6.2. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden?

![Figure 31: Activities and solutions in collaboration with suppliers to reduce inventory level](image)

6.2.1. What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden?

As the researchers have identified in the theoretical part, three factors linked to the relationship between suppliers and a buying company can influence inventory level: replenishment lead time, the supplier relationship and the information sharing process. In the case of Papyrus Sweden, the authors are then going to verify this theoretical statement.

As Kouvelis and Tang (2012) have written, upstream supply chains tend to be longer in a context in which products have to cross borders and longer distances. Indeed, while working with Papyrus Sweden, the authors have noticed that the three main suppliers are spread out around Scandinavia, which creates long replenishment lead times and so uncertainty (Jacob et al., 2009). Thus, still according to Jacob et al. (2009), lead times can be unstable, which forces companies such as Papyrus Sweden to hold inventory in order to avoid risks linked to uncertainties of replenishment lead times. Furthermore, as Silver and Zufferey (2011), Silver et al. (1998) and Chew et al. (2013) have identified, the replenishment lead time can be divided in
three components: transit time to customer, time at the supplier and transportation time. Obviously in the case of Papyrus Sweden, the transit time to customer does not vary, as a fixed process has been implemented for the replenishment of each SKU. However, the two other components are subject to variability and highly depend on the supplier relationship, such as Silver and Zufferey (2011) have identified. Thus the choice of suppliers and the supplier relationship management appear as keys for Papyrus Sweden, in order to maintain low inventory level via high reliability toward suppliers and stable lead times.

In addition, as Hsu and Lee (2009) have written, Papyrus Sweden could benefit from shorter replenishment lead times by having lower safety stocks, less stock-outs and a better service level (6.1.1 Material planning methods and 6.1.2 Safety stock calculation).

In order to have short and reliable lead times, a company such as Papyrus Sweden then has to develop long-term relationships with its suppliers. In this objective, Papyrus Sweden must take into account four criteria when dealing with its suppliers which are: reliability, quality, accuracy and flexibility (Schönsleben, 2010). Indeed, having a supplier answering these criteria, Papyrus Sweden would then be able to reduce its purchasing costs, decrease its replenishment lead time and increase its service level (Wu et al., 2013). Moreover, still according to these authors, establishing a long-term relationship is a necessity for companies such as Papyrus Sweden which evolves in a highly competitive environment. And fortunately for Papyrus Sweden, its relationships with its main suppliers are already based on trust and respect. In fact, Papyrus Sweden sees its relationship with its three main suppliers as a win-win situation in which both parties must find advantages (Olofsson, 2013e). As seen in the empirical part, these relationships are long-term relationships in which both parties have grown together when the market was expanding and both parties are now motivated to help each other on the declining market. In this vision, Papyrus Sweden then begins to work in collaboration with its supplier to reduce replenishment lead times and improve reliability and stability in the upstream supply chain in order to reduce inventory levels.
In addition of reducing lead time and uncertainties, reliable suppliers insure less failure in delivery which will positively impact inventory levels (Osman and Demirli, 2012). Indeed, Papyrus Sweden aims at creating reliability with its partners, as Per Olofsson highlighted, reliability in suppliers will bring stability in the whole upstream supply chain.

Finally, in order for these relationships to be reliable, stable and based on long-term, Papyrus Sweden has to share information with its suppliers. According to Lee et al. (2000), information sharing enables a merchant company such as Papyrus Sweden to better match supply and demand, which in return can help such an organization to reduce its inventory levels. Moreover, in order to work in collaboration, suppliers and Papyrus Sweden must share information on a continuous basis (Stein and Sweat, 1998). Indeed, as Yu et al. (2001) have identified, exchanging information can among other advantages, decrease the bullwhip effect by having a better visibility on demand, which helps reducing inventory levels. In the research case, Papyrus Sweden does share information with its main suppliers via a shared EDI on which the majority of flows are managed. However, the only information Papyrus Sweden shares with its suppliers concerns purchase orders, purchase order confirmations and invoicing.

Yet, according to Barrat and Oke (2007), greater exchange of information does not lead to greater performance. Only the exchange of valuable information is necessary among partners, and Papyrus Sweden then has chosen to exchange only information on orders and invoicing. In this vision, the researchers have then identified that Papyrus Sweden does not use any MRP or ERP in collaboration with its suppliers but only this EDI.

Thus to sum up, according to the three activities identified as influencing inventory level which are replenishment lead time, supplier relationship and information sharing; Papyrus Sweden seems in a stable situation. Indeed Papyrus Sweden has developed long-term relationships with its three main suppliers, with whom it shares essential information regarding orders via a common EDI. These relationships are based on trust, yet suppliers are not yet reliable enough. Indeed, replenishment lead times are subject to fluctuations which bring uncertainty in the upstream supply chain and forces Papyrus Sweden to hold inventory level. In order to help
Papyrus Sweden, the researchers will in the following part consider different options implying collaboration between Papyrus Sweden and its suppliers in order to reduce inventory level. Therefore, for Papyrus Sweden to obtain quick results the researchers will then offer a short term solution, which does not imply too much investment and prerequisites to be implemented; to later suggest a long-term solution to stabilize the supplier relationship, bring stability and reliability in the upstream supply chain and mostly decrease inventory level.

6.2.2. What solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden?

As explained, the researchers will now suggest two solutions for Papyrus Sweden to decrease its inventory level via collaborative actions taken with its main suppliers. In a first part, the authors will present a short-term solution in collaboration with suppliers to decrease inventory level, i.e. implementing a Service Level Agreement (SLA), that could be developed over a short term period (within a year) and enable Papyrus Sweden to bring stability in its upstream supply chain. In a second part the authors will then suggest a long term solution among two options: a Vendor Managed Inventory system (VMI) or a Collaborative Planning, Forecast, Replenishment model (CPFR), based on stability and reliability created via the SLA implementation, that could enable Papyrus Sweden to significantly decrease its inventory level and improve its upstream supply chain performances.

6.2.2.1. Short term solution: Service Level Agreement (SLA)

According to Osman and Demirli (2010), a solution to reduce inventory level is to have reliable suppliers and short replenishment lead times. This vision is shared by Per Olofsson, supply chain director at Papyrus Sweden, who considers that stability should be brought in the upstream supply chain (Olofsson, 2013a). Thus, coordination and partnership are needed (Tan et al., 1998; Lee et al., 2001) in order to establish a network able to accomplish upstream supply chain goals (Hajji et al., 2011). Per Olofsson then advocates that implementing a Service Level Agreement (SLA) can be a solution to bring this stability inside Papyrus Sweden upstream supply chain and reduce inventory level. As having the right suppliers allows a company to have reliable flow, shorter lead time and so lower inventory levels (Osman and Demirli, 2012).
As explained in the theory an SLA is an agreement between a buying company and its suppliers regarding a certain service level suppliers must achieve and a set of measurements to control suppliers performances (Parish, 1997; Hiles, 1994). It can then be seen as the first step to create supplier reliability by setting targeted performances and agreeing on delivery conditions that the suppliers have to respect. Papyrus Sweden already having long-term relationships with its three main suppliers can consider launching such a project to fix expectations regarding reliability, lead time and delivery accuracy; reach stability and reduce its inventory level.

Moreover, an SLA is based on Key Performance Indicators (KPIs) which measure actual performance against target performance (Hiles, 1994). Papyrus Sweden is, as Papyrus Germany, using a reporting tool which already encompasses performance measurements. Indeed, Papyrus Sweden already assesses its suppliers on delivery time and delivery reliability by calculating the first requested time (+/- 1 day) comparing the number of order lines delivered from requested date and the total number of order lines fully delivered; the first confirmed time against the delivery time by comparing the number of order lines delivered according to the confirmed date and the total number of fully delivered order lines; the last confirmed delivery time by comparing the number of order lines delivered according to the last confirmed delivery time and the total number of fully delivered order lines and finally the actual replenishment lead time. Already having this tool, Papyrus Sweden is able to highlight unreliability of its suppliers. However, it is also a tool that could be used as a basis to develop SLA with the main suppliers as KPIs are already calculating the main criteria needed to be assessed in a SLA and they clearly show the lack of performance coming from the suppliers. And that is what happened in Papyrus Germany, where a first version of SLA has been implemented in 2012. Thus, using this tool, the German branch of Papyrus has been able to develop an SLA with its main suppliers. Yet, the project still being in progress, the researchers have not been able to quantify its positive impact on inventory level or supplier reliability.

Indeed, Papyrus Sweden could follow the German model in order to fast implement an SLA with its own suppliers. Thus, Papyrus Germany has first fixed agreed replenishment lead time for each SKU to then implement an SLA based on KPIs. According to Parish (1997), calculations in a
SLA usually include response lead time, on time deliveries and reliability target. Yet in the case of Papyrus Germany, SLA is based on KPIs assessing these fixed replenishment lead times, delivery reliability, minimum order quantity on SKU level and minimum delivery quantity (Olofsson, 2013a). To sum up, the German SLA measures three main criteria which are delivery reliability, delivery volume and replenishment lead time, in order to decrease inventory level by bringing stability to the upstream supply chain. However delivery reliability was the main motivator to develop this SLA. In fact, the main idea was to reach 90% delivery reliability with this new tool in order to bring stability, i.e. decrease uncertainty and so inventory level via reducing safety stock levels.

Finally an SLA is a compromise between what the buying company expects the supplier performance to be and what the supplier is actually able to deliver (Parish, 1997). Indeed, before even considering calculations and performance measurements, Papyrus Germany has first identified its own expectations and its suppliers’ expectations. Such as Papyrus Sweden, Papyrus Germany aimed at bringing stability in its upstream supply chain mainly through reliability. Its expectations were then to have reliable suppliers and delivery accuracy and reliability. Its motivation to have an SLA was then to be able to frame the supplier performance in order to reduce inventory level via lower uncertainties. However, Papyrus Germany had to take into account its suppliers’ expectations too which were not to increase their own costs and to receive accurate forecasts. In this vision, Papyrus Sweden is exactly in the same situation, as it is working with the same suppliers as Papyrus Germany. Thus, Papyrus Sweden has first to fix its own expectations toward this Service Level Agreement and take into account its suppliers’ expectations in order to implement a tool respecting the win-win situation in which they evolve. In Germany, it has been established that if the forecast inaccuracy is above 5%, the suppliers performance concerning on time delivery cannot be assessed in the SLA. Therefore Papyrus Sweden has first to improve its forecast accuracy to then be able to provide accurate data to its suppliers who in return could insure higher reliability (6.1.4 Forecast calculation)

Furthermore, the purpose of having a SLA is to share responsibility of inventory level between partners by involving suppliers and ensuring accurate deliveries (Parish, 1997). Also according to
this author, a SLA can then smoothen uncertainties by ensuring supplier reliability, which reduces inventory level. It can then be seen as the first step to later implement a collaborative model (6.2.2.2 Long term solution: CPFR vs. VMI) in which Papyrus Sweden and its suppliers could work together in order to bring stability in the upstream supply chain, to improve the upstream supply chain performance and reduce inventory levels.

6.2.2.2. Long term solution: CPFR vs. VMI

The researchers have identified two long term suggestions that could get implemented at Papyrus Sweden in order to decrease the company’s inventory levels while working in collaboration with the main suppliers: a Collaborative planning, forecasting and replenishment system (CPFR) and a Vendor Managed Inventory system (VMI). Implementing both options would not be a good strategy for Papyrus Sweden since they take time to implement, to run and to improve. Therefore the researcher group will compare both suggestions and see which of the two alternatives is the most adapted to Papyrus Sweden both in terms of ease to implement in Papyrus Sweden current structure and considering the impact it would have on the decrease of inventory levels.

Collaborative Planning, Forecast and Replenishment (CPFR)

As seen earlier in the theory chapter, CPFR is a tool that aims at replacing the traditional Electronic Data Interchange system (EDI) in use within most of today’s organizations (Fliedner, 2003). With a CPFR system the information exchanged between the buying company and its suppliers goes beyond the basic order confirmation and invoicing exchanged has it integrates information sharing on inventory level, replenishment, purchase planning, demand forecasting and inventory refill (Fliedner, 2003). Today Papyrus Sweden does not push information sharing to this extant, in practice the only tool Papyrus Sweden has is an EDI which sticks to basic information flow exchange: purchase order, purchase order confirmation, order confirmation and invoicing. Enlarging the use of Papyrus Sweden EDI toward the integration of collaborative planning and forecasting tools would be the first step toward the implementation of a CPFR and could have direct impact on the way inventory levels are management today in Papyrus Sweden. Also one of the main advantages that CPFR would have over the current EDI system at Papyrus
Sweden is the rapidity of information flow both within the company and with its suppliers (Joachim, 1998; Cooke, 1998). This is something crucial as the authors underline. Not only does the quality of the information shared is a central point but the period that elapses between an information being processed and the same information reaching Papyrus Sweden partners has to be as short as possible. With an efficient CPFR system the information flow becomes instantaneous. One of the weaknesses that the researchers group has identified when gathering information on Papyrus Sweden and despite not having had access to the supplier vision on this relationship, is the lack of collaboration between the two parties. With a CPFR system instant access is given to all the internal data linked to planning, forecasting and replenishment to the suppliers. For Papyrus Sweden this would enable the company to work hand in hand on those topics in a collaborative way and would enable the suppliers to react more rapidly to changes in forecasts as the information flows. This would have an impact on inventory levels as more accurate forecasts and due timed release of replenishment orders would be achieved with a CPFR system (Fliedner, 2003).

A downside of the CPFR implementation, more than the time consumption of the implementation and proper running of such a web-based structure, are the prerequisites in terms of supplier-buyer relationship. Indeed Hamilton (1994) and Stedman (1998) illustrate how trust and long term partnerships are needed in order for a CPFR implementation to be successful as a major part of a CPFR system relies on the exchange of sensible data which can be perceived by the company as a risk. But for Papyrus Sweden this does not represent a weakness but a strength. Indeed over time Papyrus Sweden managed to build a strong long term relationship with its main suppliers. Taking the example of Stora Enso, one of today’s main suppliers of Papyrus Sweden, the history between the two companies should ease the setting of such collaboration as for a long period of time and until the beginning of the 21st century the two companies were just one entity.

**Vendor Managed Inventory (VMI)**

The second long term alternative that is offered to Papyrus Sweden in order to decrease its inventory level is the implementation of a VMI system. The VMI solution goes beyond the CPFR
system as it pushes the integration and the collaboration of both Papyrus Sweden and its suppliers to another level. Here, the supplier is in charge of each item inventory level and more globally part of the inventory policies (Bowersox et al., 2011; Christopher, 2005; Jonsson, 2008). Again the sharing of information is a crucial part of VMI as it enables the suppliers to be constantly aware of the inventory situation and to react adequately to inventory level variations. VMI relies on the setting of common agreements between both parties and requires strong long term relationships between Papyrus Sweden and its suppliers. An advantage that Papyrus has is that VMI implementation is something that has already been done in Switzerland and more recently in Germany with common suppliers that have the knowledge of how to implement such a structure and that have transmitted this knowledge to Papyrus over time. Of course for Papyrus Sweden before starting to implement a VMI and despite the fact that the relationship it has with its main suppliers is already mature, the way it handles forecasts and classify products has to be improved in the first place since it is essential that both Papyrus Sweden and its affected suppliers are able to build reliable forecasts and to predict market behavior (Angulo et al., 2004). Per Olofsson guided the researchers group through the main achievement of a VMI structure in Papyrus Switzerland. He explained that for the company main benefits leading toward inventory level reduction have been made possible. First the decrease of days in demand concerning inventory level has dropped from an average of 18 days to 10.5 days, which shows that with a VMI system the number of small short term replenishments increases and therefore Papyrus Switzerland managed to limit unnecessary overstock with a decrease in stock keeping value of 60%. VMI has also been a way to fight delivery lead time fluctuations. Indeed as control over inventory levels is given to the suppliers, the suppliers’ involvement and necessity to respond to the service level agreements settled with Papyrus Switzerland pushes it toward the achievement of increasing reliability. Finally VMI has had an impact on delivery optimization since the suppliers decide when a delivery is made, on which items and in which quantities, it gives themselves the opportunity to proceed to the most efficient product mix when delivering full truckloads (Kaipia et al., 2002; Disney and Towill, 2003; Smaros et al., 2003, Holweg et al., 2005).
VMI: a more suitable long term solution for Papyrus Sweden

The researchers group believes that following the comparison of both long term suggestions, VMI overtakes CPFR in terms of benefits affecting overall inventory levels and is more suited to Papyrus Sweden since a lot of prerequisites to the implementation of VMI are present in today’s relationship between Papyrus Sweden and its main suppliers. Moreover interacting with the same suppliers as Papyrus Switzerland and working according the same processes and strategy, Papyrus Sweden would be able to efficiently implement a VMI, based on what has already been done in Switzerland.

According to the researchers group Papyrus Sweden could follow on the short term a SLA strategy while internally working on some of its processes in order to improve forecasting accuracy and ABC-XZY classification of its item so that the organization achieves the optimal safety stock level for each item according to their targeted service level. Establishing SLA will give Papyrus Sweden a good base for the VMI implementation as it will enable the organization to select the suppliers it wants to collaborate more closely with on the bases of their reliability. Indeed according to the current situation the researchers group feels the need to first agree on delivery requirements in order then to progressively transmit the control of inventory levels to the suppliers. According to the time it took to implement a VMI system in Papyrus Switzerland it can be predicted that at least 4 years of implementation and running will be necessary before achieving the targeted decreases in terms of inventory level. Indeed there is first the technical aspect of this implementation as the current replenishment system (E3) used by Papyrus Sweden has to be restructured in order for the suppliers to get access to all the information regarding forecasts, point of sale data and inventory level (Disney and Towill, 2002); information that constitute the backbone of a VMI architecture. In addition the transfer of inventory control over goods has to be progressive; the vendor managed items would first be represented by high runners (Bohnen et al., 2011) (3.1.3 ABC- XYZ classifications of products, Figure 8), i.e. goods that represent a large volume of sales and with frequent demand. Low runners, considered more difficult to handle in term of inventory but also less worthy, will be transferred to the suppliers in last resort. Thus, implementing a VMI first depends on forecast accuracy improvement and ABC-XYZ classification. This solution then depends on suggested solutions within Papyrus Sweden offered in the previous part 6.1 which are prerequisites to solutions implemented in collaboration with suppliers.
7. CONCLUSION

In this chapter the researchers will sum up their findings regarding Papyrus Sweden upstream supply chain and go through the suggested solutions that could be implemented within the organization and in collaboration with its suppliers in order to reduce the level of inventory at Papyrus Sweden.

Along the previous chapters, the researchers responded to the following research questions with the help of data collected from Papyrus Sweden and processed by the researchers:

- What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level?

- What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden?

7.1. **What upstream supply chain activities within Papyrus Sweden influence inventory level and what solutions can be suggested within Papyrus Sweden in order to reduce inventory level?**

The researchers group first considered that there are a number of practices that could be pursued or transformed internally on the short term in order for the organization to strengthen the way inventory levels are currently handled. Papyrus Sweden’s material planning method, the way it calculates its safety stocks, its item classification according to the ABC-XYZ analysis and finally its forecasting method; those are the activities identified by the researchers that have an impact on the level of inventories and on which Papyrus Sweden could carry out internal optimizations.

Indeed Papyrus Sweden material planning method follows the Re-Order Point method (ROP). The researchers have shown that this method is in adequacy with the activity of Papyrus
CONCLUSION

Sweden: a merchant company that brings value to its end consumers through the consolidation and distribution of a wide range of paper products. This method is therefore seen as the most efficient for Papyrus Sweden and no recommendation could be made by the researchers since Papyrus Sweden’s practice is considered optimal.

However the researchers have identified that Papyrus Sweden's safety stock calculation had room for improvements. Following the analysis of the sales and inbound data given to the researchers group on a one year period of time, it was found that the service levels achieved by Papyrus Sweden experience significant variations going from 83% to 100% depending on the products. Yet its average of 96% corresponds to the targeted service level of B class and unclassified products. For the company, this wide range of service levels has an impact on inventory carrying costs. The analysis even showed that in some cases the inventory level average exceeds the maximum service level of 100% which is basically a lot of work done by Papyrus Sweden to achieve a quality of service level the customer will not even perceive nor appreciate. Knowing that, the researchers’ interpretations cannot be stated as proved as the number of samples is too low for a scientific statement to be made. However, the researchers also suggest a change of safety stock method as the standard safety stock method would have a major impact on Papyrus Sweden average inventory level, decreasing the overall volume of capital tied up.

In addition, the ABC-XYZ classification is highly connected to service level. Therefore, Papyrus Sweden does assign its items to a targeted service level. Unfortunately the researchers could not proceed to a deep analysis of the ABCD classification made by the company since they were not given access to a data sample representative of the overall product class distribution. The main finding brought by the researchers group relates to unclassified items. Their status should be updated in order for them to be assigned to the correct service level targeted according to their demand pattern. Moreover the researchers group suggests connecting the ABC classification with an XYZ analysis considering the variability in demand experienced by some of the data sample items. In practice not all items follow the same trends, and connecting the ABCD analysis to an XYZ classification would enable Papyrus Sweden to define appropriate service level targets
for each item according to their demand frequency and sales volume and therefore adapt the
safety stock levels adequately.

Finally, Papyrus Sweden and the researchers have identified forecast accuracy as a prerequisite
for greater supplier reliability and therefore inventory level reduction. The researchers consider
that Papyrus Sweden is currently using the most accurate forecasting system in comparison to
other available methods. Indeed Papyrus Sweden is using a time-series approach which relies on
creating a sales forecast based on past demand data. The researchers underlined the influence
of smoothing variable on the forecasting accuracy as different time periods should be treated
differently. A significant understanding relies on the importance of manual adjustments made on
forecasts within Papyrus Sweden; therefore Papyrus Sweden should pay great attention to its
employees and to its knowledge of demand patterns, trends and seasonality. Since demand
fluctuations is a considerable issue for Papyrus Sweden and inevitably leads to a greater level of
safety-stock in order for the organization to achieve its targeted service levels, the researchers
suggest that Papyrus Sweden gives credit to employee’s manual adjustment on calculated
forecast as their assessment of seasonality and trends based on experience is of great value.

To sum up, the researchers have come up with several suggestions Papyrus Sweden could
implement in intern in order to reduce its inventory level. Those suggestions can be seen in the
following Figure 32.
How to reduce inventory level within Papyrus Sweden?  | Papyrus Sweden situation  | Suggestion made by the researchers  
--- | --- | ---  
Material planning methods  | Re-order point method  | No suggestion  
Safety stock calculation  | Secret formula hold by the replenishment system E3  | Develop a standard safety stock calculation  
ABC-XYZ classification  | An ABCD classification not reviewed regularly, no XYZ classification  | Review the ABCD classification & implement a XYZ classification linked to ABCD products  
Forecast calculation  | Self-developed formula and competent manual adjustments  | High forecast accuracy, yet product seasonality could be reviewed

7.2. **What upstream supply chain activities in collaboration with suppliers influence inventory level at Papyrus Sweden and what solutions can be suggested in collaboration with suppliers in order to reduce inventory level at Papyrus Sweden?**

The researchers have considered activities in collaboration with Papyrus Sweden's suppliers that have an impact on inventory level and have suggested solutions in order to reduce inventory level. By doing so, the researchers have first identified three activities influencing inventory level i.e. replenishment lead time, the supplier relationship and information sharing. After having evaluated the influence of these activities on inventory level according to theory, the researchers have evaluated those criteria in the situation of Papyrus Sweden.

The researchers have then discovered that long replenishment lead times have in theory a negative impact on inventory level. Indeed, long replenishment lead time brings uncertainty in the supply chain which forces Papyrus Sweden to hold higher safety stocks. Moreover, Papyrus
Sweden is confronted to low supplier and delivery reliability, which increases even more uncertainties in the upstream supply chain and justifies high inventory levels. In addition, even if Papyrus Sweden has been working for many years with its three main suppliers, the only data it shares via the EDI only concerns purchasing orders and invoicing. Finally, being on a declining market, Papyrus Sweden cannot afford to decrease its service level. Its only way to reduce its costs is then to decrease its inventory levels. In this situation, Papyrus Sweden appears motivated to work on the supplier relationship in order to bring stability to the upstream supply chain and thus decrease inventory level.

According to this vision, the researchers have then suggested two solutions that Papyrus Sweden could implement in collaboration with its main suppliers in order to reduce inventory level. Indeed, the researchers group has first identified a short-term solution, which would need little investment and prerequisites: a Service Level Agreement (SLA). This SLA would establish a contract between the suppliers and Papyrus Sweden according to the supplier service level required. This could enable Papyrus Sweden to stabilize its flows and upstream supply chain while increasing suppliers’ reliability, which are prerequisites to implement a collaborative solution with suppliers. The second suggested solution would then be a long-term collaborative solution, based on the SLA results, i.e. a Vendor Managed Inventory (VMI) system.

The researchers then suggest that Papyrus Sweden could first implement a SLA. Thus, Papyrus Sweden could get inspired by Papyrus Germany and implement a SLA in which the company would be able to fix replenishment lead times for each SKU and assess supplier performance according to delivery reliability and accuracy. In doing so, Papyrus Sweden could base its SLA on the existing reporting tool that it already uses and fix targeted objectives regarding lead time and reliability the suppliers will have to reach. By doing so, Papyrus Sweden could bring stability inside its upstream supply chain, decrease uncertainties by fixing replenishment lead times and increasing reliability of suppliers, and so reduce its inventory level without decreasing its service level. Moreover, establishing this stable situation, Papyrus Sweden would then be able to implement a long-term solution in collaboration with its suppliers in order to improve its upstream supply chain efficiency, i.e. a Vendor Manager Inventory model.
For Papyrus Sweden the main benefit of a Vendor Managed Inventory (VMI) implementation is that over the years, Papyrus has started to develop efficient VMI structures in Europe and therefore has strong bases and a network of long term suppliers with whom extended collaborations are possible. According to theory and to Papyrus Switzerland’s recent implementation of VMI, this long term process leads to significant decrease in the company’s tied-up capital as the inventory days in demand decreases with greater sequenced replenishments. Meanwhile as the suppliers’ involvement increases, its reliability is fostered enabling Papyrus Sweden to progressively reduce its safety stock level as inbound get secured. Finally, a VMI could be an answer to the issue of delivery optimization as the supplier is given the opportunity to proceed to the most efficient product mix when filling full truckloads. Therefore suppliers bring their knowledge of product range while having vision over Papyrus Sweden inventory level for each item.

To sum up, the researchers have come up with two suggestions Papyrus Sweden could implement in collaboration with its main suppliers in order to reduce its inventory level. Those suggestions can be seen in the following Figure 33.

![Figure 33: How to reduce inventory level at Papyrus Sweden in collaboration with suppliers?](image)

Therefore, the researchers have identified a chronology when it comes to the suggestions’ implementation. Indeed, following their analysis of Papyrus Sweden results and the study of
their activity giving a close focus to the degree of collaboration that exist between Papyrus Sweden and its main first tier suppliers, the identification of short term recommendations that could constitute prerequisites to long term suggestions have been made in order to lead Papyrus Sweden toward the reduction of its inventory levels.

An action plan can then be suggested as follow in Figure 34.

![Figure 34: Suggested action plan](image)

**Limitations of research**

The authors are aware of certain limitations of their research. Indeed, they have decided to take into account only activities influencing inventory level linked to upstream supply chain while activities regarding downstream supply chain can also have an effect on inventory level such as advertising and promotions or customer service management. This choice has been made regarding Papyrus Sweden situation and orientation toward the supplier relationship. In fact, the company has first clearly stated its interest in decreasing its inventory level via improving the supplier relationship. Therefore the authors have limited their research to upstream supply chain and activities linked to the supplier relationship. Yet, the biggest limitation the authors
have encountered is that they were not able to contact the suppliers for political reasons. Indeed, the only contacts available to the researchers were internal to Papyrus Sweden.

In addition the researchers faced limitations in the data they have received. Indeed, in order to offer their suggestions, the authors needed hard data concerning inventory level, products and sales. Papyrus Sweden has only provided them data concerning 42 products out of thousands, which were classified only as B class or unclassified products and which were supplied by only two of the three main suppliers Papyrus Sweden is working with. Moreover, the analysis made by the researchers could not have been as deep as expected as the data received only concerned a one year period which prevented the researchers from analyzing seasonalities for instance. Finally, the data received contained no financial data.
REFERENCES


REFERENCES


REFERENCES


REFERENCES


REFERENCES


Olofsson, P., 2013e. Fifth interview of Supply Chain Director. Interviewed by Researcher Group, Olivier, M., Bellina, J., Krieger, S. [phone interview] Växjö, Friday 10 May from 9:00.


REFERENCES


