PROFITABLE NEGOTIATIONS
A CASE STUDY REGARDING PURCHASE-, TRANSPORT- AND INVENTORY COSTS AT ABB

Emma Hall
Jenny Furusköld

Supervisors: Malin Wiger (Liu), Samuel Grennhag (ABB) and Martin Thored (ABB)
Examiner: Mats Abrahamsson
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ABSTRACT

ABB is a global company with a leading position in power and automation technologies. Being active on a global market creates a high pressure to always develop the business and reduce costs in order to stay competitive. The purchasing function at ABB’s unit Control Products is divided into a strategic- and an operative purchase department. The negotiated setups the strategic purchasers establish with the suppliers have been shown to affect the transport- and inventory costs that are charged to the operative purchase department. In order to determine whether more beneficial setups could be negotiated by including transport- and inventory costs when they are evaluated, this case study has been requested. Two master students from Linköping University have conducted the study and by investigating different setups, conclusions to answer the study’s purpose could be drawn. The purpose is presented below.

The study’s purpose is to recommend future guidelines for the strategic purchasers at ABB’s unit Control Products that can be applied when negotiating with suppliers, by evaluating purchase-, transport- and inventory costs.

In order to investigate how the purchase-, transport- and inventory costs were affected by different setups, four different cases were defined. Each case included a specific article, which was chosen based on its properties and its current and alternative setups. The conducted literature reviews and interviews with employees at Control Products resulted in the two sub-criteria lead time and net price were defined as the most important ones when negotiating and evaluating suppliers. A combination of these sub-criteria was therefore used to choose suitable articles. Once the cases had been defined, the purchase-, transport- and inventory costs could be calculated for both their current situation and alternative setup scenarios. Theories from relevant researches were used to strengthen and criticised the cases’ results.

Each case's result provided information regarding how the purchase-, transport- and inventory costs were affected by specific setups. By comparing the alternative scenarios with the setup currently used, the alternatives’ profitability could be determined. The cases showed that by only studying one of the three cost posts, only a limited insight was gained. Even if the purchase cost was to increase for an alternative setup, it could still be profitable to implement due to decreased transport- and inventory costs. Furthermore, an alternative setup that showed significant potential to reduce inventory costs was proven to not be profitable because of its effect on the net price. Neglecting to take transport- and inventory costs into account when a potential supplier is evaluated can make a deal look more profitable than it is.

The final recommendation is that purchase-, transport- and inventory costs all have to be taken into consideration in order to determine which setups that are economically preferable. If the strategic purchasers at Control Products includes these when they negotiate with suppliers, more profitable deals can be obtained.
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Emma Hall  
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1 INTRODUCTION

This section contains an introduction of the background to this study and continues with the defined purpose. Thereafter a clarification of the purpose is presented followed by directives from ABB. The section finishes with a presentation of the outline of the report.

1.1 BACKGROUND

Nowadays the increased global competition forces companies to become better, faster and cheaper in comparison to their rivals in order to maintain a profitable market position. These external factors put pressure on businesses to reduce costs. (Saunders, 1997) To continuously develop and remain competitive it is important to work with the entire supply chain in order to avoid sub-optimization. By establishing a close collaboration between actors in the chain with the common long-term goal to grow together, a strong supply chain can be created. (Jespersen & Skjøtt-Larsen, 2005) Close relationships with suppliers provide companies with the opportunity to improve shared activities. An example is purchase, which because of its impact on companies' economic results is necessary to continuously develop to keep the companies profitable. (Van Weele, 2012)

The technical company ABB AB, hereinafter referred to as ABB, acts on the global market and is constantly pressured to reduce costs in order to stay competitive. As the company is active worldwide and holds a leading position in several technologies, such as power- and automation technology, they possess a profitable market position (ABB, 2016a). To maintain competitive, the company has several projects up and running in order to lower specific costs. As purchasing has shown to be of importance, initiatives have been taken to manage the function in a more profitable way. Both the strategic- and operative purchasing departments are continuously working to reduce costs by taking different actions based on set directives. The strategic purchasing department is pressured to choose suppliers that offer the lowest net prices and at the same time fulfil fundamental requirements for being a suitable supplier. The operative purchasing department on the other hand has more requirements regarding the products availability. (SCM manager respective Logistics & material manager, 2016)

Even though the strategic and operative departments are depending on each other the different requirements and goals often results in purchasing decisions that might be profitable from a strategic perspective but increases the cost in a wider perspective. However, if it cannot be proved that a supplier with a higher net price actually is more profitable due to the way the operative purchasers manage their daily work, the cheapest supplier will always be chosen. (SCM manager respective Logistics & material manager, 2016)
To optimize the business, a project has started in collaboration between one of ABB’s Local Business Units, LBU, called Control Products and two students studying the last year in Industrial Engineering and Management at Linköping University. The project will both result in a master thesis for the students and provide insight about the correlation between purchase-, transport- and inventory costs. Net price, is as mentioned a sub-criteria that the unit’s strategic purchasers see as the most important one (Strategic purchasers, 2016). Furthermore, both transportation- and inventory costs are today charged to the unit’s operative purchase department but determined by the negotiated terms set by the strategic purchase department (Material planners, 2016). According to previous conducted researches, transportation- and inventory costs should be taken into account when suppliers are selected or evaluated (Baily, 1997; Monczka et al., 2005; Lee & Drake, 2010; Kahji & Shafaei, 2011). Including transport- and inventory costs in future negotiations are therefore seen as a plausible way to achieve more profitable deals why this study has been requested.

1.2 PURPOSE

The study’s purpose is to recommend future guidelines for the strategic purchasers at ABB’s unit Control Products that can be applied when negotiating with suppliers, by evaluating purchase-, transport- and inventory costs.

1.2.1 CLARIFICATION OF THE PURPOSE

The study will contain an investigation concerning both current situations and alternative scenarios in regard to purchase-, transport- and inventory costs for specific cases. The purchase cost is determined by the articles’ net prices and the yearly purchased quantity. The transportation cost reflects the cost of transporting the goods from the suppliers to Control Products in Västerås. Finally, inventory costs include both the pipeline inventory cost that occurs during transportation and the stock cost that results from tie up capital in the unit’s inventory. By taking all these cost posts into account and investigate plausible alternative scenarios conclusions can be drawn whether Control Products would benefit from taking these cost into consideration when they select and evaluate suppliers in the future.
1.3 DIRECTIVES

When the strategic purchasers at Control Products select and evaluate suppliers they take several criteria into account. The offered and delivered quality of the goods is something that is extremely important to ensure that ABB’s produced products have the expected durability. Control Products has a quality department that solely focus on questions and assignments connected to quality. Because this study is focused on the connection between the operative- and strategic purchase department, quality issues will not be further investigated. A directive has therefore been subscribed, which assumes that all studied articles uphold the expected quality.

 Directive 1: The studied articles are assumed to uphold the expected quality.

Today, ABB is not using either railways or pipelines as modes of transportation and there are no upcoming plans to change that. The usage of railway transportation might affect the transport lead time and the flexibility negatively why the option is viewed as suitable by Control Products. Pipeline transportation is also excluded from the study because of lack of transported liquids and gases.

 Directive 2: Transportations by train is not a possible scenario for ABB nowadays and will therefore be overlooked in the study.
 Directive 3: Transportation by pipelines is not a possible scenario for the unit and will therefore not be evaluated in the study.

The unit has previously measured the interest rate and it is defined to nine percent. Because this value is used throughout the company a further analyse whether this is optimal will not be a part of the study.

 Directive 4: An interest rate on nine percent will be used.
1.4 OUTLINE OF THE REPORT

The structure of the report is based on the headings presented below. A brief presentation regarding the different sections’ content is also described.

INTRODUCTION
The first section of the report includes a background to the study followed by the defined purpose and the given directives from ABB.

COMPANY PRESENTATION
The section contains information about the studied company and how purchasing is currently handled followed by a description regarding the inbound transportation and inventory management.

THEORETICAL FRAMEWORK
The result of conducted literature reviews are presented in this section and the gained information acts as a foundation for the rest of the report.

PROBLEM SPECIFICATION
This section declares the problem by a presentation of what will be included and investigated in the study and it ends with defined research questions.

METHOD
The way the study has been performed and the way the research questions have been answered are presented in this section together with criticism of the applied method.

CASE PRESENTATIONS AND ANALYSES
The section presents collected empirical data, which together with the studied theories were used to analyse the different cases.

CONCLUSIONS
The study’s conclusions are presented and are aimed to answer the purpose of the study.

DISCUSSIONS
The arisen circumstances during the study and suggestions for future investigations are discussed in this final section of the report.
2 COMPANY PRESENTATION

This section aims to present ABB and it will start with a review over the company’s history. An explanation regarding the way ABB is organised and more detailed information concerning the unit Control Products is also presented, followed by an overview of its purchasing departments. The section finishes with an introduction of the unit’s current transportation- and inventory managements.

2.1 HISTORY

ABB’s history takes its start in the Swedish capital Stockholm, where Ludvig Fredholm in the year of 1883 founded the company Elektriska Aktiebolaget that produced generators and electrical lighting. A junction between Fredholm’s original company and Wenströms & Granströms Elektriska Kraftbolag resulted year 1890 in the creation of a new company named ASEA. By producing and developing electrical equipment, power transmissions, transformers etcetera, the company grew and became a strong competitor on both the local and the global market. A historical moment occurred in 1988 when ABB was founded by a junction between ASEA and the Swiss company Brown Boveri. Since then ABB has acquired several other technical companies to obtain even more competences and power. (ABB, 2016c)

2.2 ABB’S ORGANISATION AND PRODUCTS

ABB’s continuous growth has today resulted in a leading position in power and automation technologies. ABB enables their customers to improve their performance by delivering complex technological products with high quality. The company’s innovative approaches make them the world’s biggest supplier of power grids, motors and drive systems for the industrial market and generators for the wind power industry. ABB is operating in roughly 100 different countries with about 140 000 employees all over the world and with the headquarters located in Zürich, Switzerland. (ABB, 2016a)

ABB is organised into four global divisions that serve utilities-, infrastructure- and also industry and transport customers. The four divisions are Power Grids, Electrification Products, Discrete Automation and Motion and Process Automation. Each division exists on the global market with several BUs around the world. The BUs holds the full responsibility for the unit’s result. The BU also coordinates a global collaboration between the different LBUs to manage both marketing and sales of the unit’s products in a way that leads the unit against an increased profitability. While the BUs act from a broader perspective the LBUs focus on specific markets. (Logistics & material manager, 2016) The division Electrification Products has one LBU located in the Swedish city Västerås and its connection to the organisation is visualised in Figure 1 below.
Figure 1: Illustration over ABB’s organisation structure. The image shows how the LBU Control Products is connected to ABB’s organisation (Logistics & material manager, 2016).
2.2.1 ELECTRIFICATION PRODUCTS

Under the global division Electrification Products, ABB manages the production of low- and medium-voltage solutions, which are compatible with a wide range of electrical systems. The manufacturing gives customers in all major industries the opportunity to connect, protect, control and measure their individual system to create a more effective and safe working environment. (ABB, 2016d) One of Electrification Products five BUs is called Protection and Connection. (Logistics & material manager, 2016) Furthermore Protection and Connection has a LBU called Control Products that will be further analysed in this report.

CONTROL PRODUCTS

The LBU Control Products is producing several different products that all serve to help customers to improve the reliability and efficiency of electrical installations (SCM manager respective Logistics & material manager, 2016). The products are used in solar- and wind power plants, industries, buildings and infrastructures. Two of the main products manufactured at the unit’s production facility in Västerås are softstarters and contactors. (ABB presentation, 2015)

A softstarter is a complement to a machine that increases its lifetime by lower starting currents through the machine (ABB presentation, 2015). Examples of necessary components to assemble softstarters are circuit boards and thyristors (Strategic purchasers, 2016). In Figure 2 different sizes of softstarters are visualised. A contactor on the other hand acts as a big switch button that detect when its magnet field is broken and then switch of the current to the machine. Control Products produced contactors with different sizes because the correlation between size and ability to handle amperage. A contactor consists of components like circuit boards, magnets, coils and it is encased in thermosetting resin. (Production operators, 2016) Figure 3 shows a picture of different sizes of contactors.

![Figure 2: The picture shows different sizes softstarters](ABB presentation, 2015).

![Figure 3: The picture shows different sizes on contactors](ABB presentation, 2015).
2.3 PURCHASING AT CONTROL PRODUCTS

The purchasing function at Control Products is divided into a strategic- and an operative purchase department. Each of the department’s job assignments will be described below.

2.3.1 OPERATIVE PURCHASE DEPARTMENT

The material planners at Control Products are accountable for purchasing articles to the produced end products or material: contactors, softstarters, pilot devices, magnets and plastics. Based on the set parameters negotiated by the strategic purchasers, the material planners place orders in the business system SAP. When the inventory level for an article reaches the order point, the accountable material planner is sent a notification that it is time to place a new order. The order point is monthly updated manually to match the forecast and the inventory levels. Collaboration with some of the suppliers has been established in form of implementing an EDI, Electronic Data Interchange, solution. In addition to the order invoice, the cost for transportation and custom are sent in separate invoices to the operative purchase department. (Material planners, 2016)

Generally it is important to avoid shortage of material because it can cause production stops. The material planners therefore feel pressure, both from production personnel and other employees at the unit, to always order enough material. As a consequence the ordered quantities are usually at the upper edge of what is needed, which leads to high inventory levels. (Material planners, 2016)

Supply developers are a part of the operative purchase department and their assignments are to further develop the classified key suppliers and they also act as a link between the operative- and the strategic purchase departments (Supply developers, 2016). The unit’s key suppliers are determined based on factors such as single source, patents and unique knowledges (Supplier development engineer, 2016).
2.3.2 STRATEGIC PURCHASE DEPARTMENT

The strategic purchase department at ABB consists of a team of employees that conduct the continuously work to negotiate with both current suppliers and potential new ones. The most prioritised sub-criteria for the strategic purchasers is the net price, which always should be stretched to its limits without compromising the quality (SCM manager respective Logistics & material manager, 2016). The yearly goal is to bargain with the suppliers and reduce the net prices by five percent. As a result, some of the purchased materials have been bought from countries located in Asia where a cheaper net price could be offered. The net prices have however lately started to increase as a result of the countries’ continuous development, why vendors that are located closer are now again investigated. (Strategic purchasers, 2016)

The lead time is another important sub-criteria and it consists of the supplier’s production lead time and the lead time for transportation between suppliers and ABB. Even though the transportation lead time might be short, the production lead time can be long as a result of other actors in the supply chain. (SCM manager respective Logistics & material manager, 2016)

Other sub-criteria that the strategic purchasers are negotiating about are minimised order quantity, inventory management, inventory location, payment terms and set costs (Strategic purchasers, 2016). A summary of the sub-criteria is presented in Figure 4.

![Figure 4: A summary of the sub-criteria that strategic purchase can negotiate with.](image)

There are six different product groups that are handled separately by one strategic purchaser. In each group there are several suppliers, which produce a variety of different products. Depending on what kind of article, raw material or services that is purchased, different conditions and complications have to be dealt with to ensure a successful affair. Variation in lead times, net prices, order quantities and number of possible suppliers affect the negotiation plans. (Strategic purchasers, 2016)

Collaboration with dual suppliers is a way to reduce risks, which can be suitable if a component is critical and hard to obtain. If something would happen with one of the suppliers, there is still another one that can deliver the products. Investigating different suppliers also puts pressure on existing vendors to lower their offered net prices if they want to keep their position as a supplier to ABB. (Strategic purchasers, 2016)
2.4 TRANSPORTATION AT CONTROL PRODUCTS

All goods that are purchased by the unit’s strategic purchasers are delivered to the Control Products from the suppliers. This flow of incoming material is defined as the inbound transportation. Everyday several trucks arrive at the unit with products and materials that are needed for the production. Because of the unit’s location, only trucks are used to transport the goods to the production facility. Suppliers located in Europe exclusively transport their goods by trucks because of the flexibility that the transport option provides. With an increased distance between the vendor and the unit, other modes of transportation are used to distribute the products. For suppliers located in Asia, both ships and airplanes are used to transport the goods to Sweden where transhipments are made to trucks. Having a well-functioning product flow from the suppliers to the production site is essential to be able to produce as planned and deliver to ABB’s customers. (SCM manager respective Logistics & material manager, 2016)

The product flow from Control Products to their customers is defined as the outgoing transportation. Because the costs of outgoing transportation cost are considerably higher than the inbound transportation, the focus has almost exclusively been on reducing the cost of products leaving the production facility. (Freight manager, 2016) By studying the variation in costs related to inbound transportation during the last four years, some trends can be identified, see Figure 5. The cost from vendors inside Sweden has been reduced constantly during the studied period. The costs related to transportation outside Sweden have been stable but during the year 2015 it has increased a lot. The results are explained by an exchange of more local suppliers to vendors operating in Asia (Logistics & material manager, 2016). The geographical distance is one factor that makes transportation costly but the main reason is based on the fact that the many of the products bought from Asia are transported to Sweden by airplanes to minimise the transportation lead time. Airplanes are classified as safer mode of transportation in comparison to ships, which affects the decision. The offshoring has also had impact on money spent on customs, which is an addition cost post that occur when purchasing from vendor outside EU. (Freight manager, 2016)
The strategic purchasers and the Freight manager decide the mode of transportation based on contracts for the whole company. The choice of mode of transportation is not challenged and investigations concerning if alternatives could be more profitable have not been done for a while. (Strategic purchasers, 2016; Freight manager, 2016) Weight, volume and the anticipated order quantity generally affect the mode of transportation. ABB always aim to stand accountable for the freight and this is called Financial Conduct Authority, FCA. The reason is the beneficial bargain position that ABB receives as a big client to transportation companies. A general assumption is therefore that using economics of scale will lead to lower prices than vendors can offer. In exceptional cases, such as purchasing from another ABB unit, the supplier is however allowed to arrange transportation. (Freight manager, 2016) All related transport invoices arrive at the operative purchase department who then ensures that all costs are documented correctly and that the billed amount is equivalent with the purchased one. When goods are purchased from countries outside EU an extra charge for customs is added on a separate invoice that is reviewed at Control Products. The custom cost furthermore depends on the bought products value, an addition custom freight cost, an insurance percent and the set duty expression. (Trade operations manager, 2016)
2.5 INVENTORY MANAGEMENT AT CONTROL PRODUCTS

The material planners have a tendency to order at the upper edge of what is needed because of the pressure to never get shortage. Missing products can cause production stops and be very costly for the company. By manually regulating the reorder point, consideration can be taken to both the historic- and the future expected demand when placing orders. (Material planners, 2016) High inventory levels are generated from this order method and cause a lot of money being tied up in inventories. Continuous improvements have however been introduced to counter the increased inventory costs. (Inventory specialist, 2016)

On Control Product’s production site, a consignment stock has been implemented for a few articles and there are ongoing investigations on whether to implement consignment stocks for more products. The supplier then store the goods in a specific area in the unit’s inventory and owns them until they are extracted to be used in the production. As the information sharing between the unit and the supplier is currently done mostly manually, this inventory solution is quite time consuming. The most common applied inventory solution is however the one called cycle stock. The inventory consists of all planned material to be used during the time until the next incoming order arrives. Depending on the delivery frequency and the expected demand, the cycle stock varies in size. Different articles also have different levels on their safety stocks at the unit. The safety stock handles uncertainties such as fluctuating incoming orders and unforeseen machine stops. (Logistics & material manager, 2016)
3 THEORETICAL FRAMEWORK

Starting from a wide perspective about supply chain management, the theoretical framework continues with a presentation of the purchasing process. Important criteria for supplier negotiations and evaluations are investigated and the section ends with a presentation of different transportation- and inventory options.

3.1 SUPPLY CHAIN MANAGEMENT

As a consequence of the globalisation that has come to characterise the development for the last couple of years, companies tend to focus more on their core competence and outsource activities that other actors can do better. When doing so, a chain of different companies and actors are depending on each other to put their resources together and create products that answers to customers rising demands. When companies plan and control their business based on factors that are specific for both their own company as well as their vendors and customers it is called Supply Chain Management, hereinafter referred to as SCM. The term SCM includes all logistics activities that are performed within a company and by other actors in the chain. Strengthen the relationships between the actors are also something that is a part of SCM. (Van Weele, 2012) By collaborating and taking a joint responsibly for other actors in a supply chain the ability to grow together is created, which gives all actors a bigger potential to increase their profit. It is common that one company in the supply chain hold more power in comparison to the others, in regard to purchasing and negotiations, because of its size or the fact that their produced products are irreplaceable. (Oskarsson et al., 2013) However, according to Saunders (1997) it is not necessary the companies’ sizes that matters but the size and knowledge within the purchasing function, which hold different priority in companies.

Working together when it comes to inventory management has an impact on how smoothly the planning of activities and processes are running. Decisions about which actors will hold the inventory, order quantity and how the material will be transported decide how well the collaboration will work. (Oskarsson et al., 2013) By establishing trust and share information concerning forecasts and inventory levels with suppliers, costs can be reduced as a result of better planning (Krajewski & Ritzman, 2002). Communication and the ability to be flexible to the partners’ demands and wishes are important to build a successful long-term relationship. If the vendors are not able to meet the firm’s demands the collaboration will however be unsuccessful. In summary, there are many aspects which should be taken into account when partnerships are established with companies in a supply chain. With good preparation and openness between the different actors costs can be reduced in several areas. Purchasing is one of the functions that hold huge potential for improvements because of the close relations between the purchaser and the vendor and also the amount of capital that is handled in this process. (Van Weele, 2012) Activities in a purchasing function will be described next.
3.2 PURCHASING

Most of the active producing companies today spend more than half of the profit on purchasing material and other products that are necessary to keep producing. Good relationships with vendors are therefore essential to in short-term keep the business profitable and in a longer term to stay competitive. (Lambert et al., 1998)

Choosing suitable vendors which can deliver the right quality, at the right time and for an acceptable price is a process which is continuously conducted. Once chosen, the collaboration with the vendor takes part in the daily routine as orders are placed and follow-up meetings are held. A purchasing function includes a wide process that contains all from defining specifications to following-up and evaluating both the supplier and their products. Furthermore, the purchasing function can be divided into both tactical purchase and an ordering function. Thus, the first part of the purchasing function focuses on finding suitable vendors and the other one works with the selected vendors on a daily basis. (Van Weele, 2012)

The design of the purchase process may vary in different organisations depending on how the company is structured and what the model should be used for (Baily, 1997; Monczka et al., 2005). An illustration over Van Weele’s (2012) interpretation of the purchasing process is presented in Figure 6.

![The purchasing function](image)

As has been visualised above, finding suitable suppliers is an important initial step to enable a successful future purchase. Furthermore, follow-up and evaluation of suppliers’ performance finishes the process and is an important step to maintain a good and profitable relationship. To manage these two vital steps, an insight in criteria that should be focused on when negotiating and evaluating suppliers is presented in the followed chapter.
3.3 SUPPLIER EVALUATION

Choosing new and evaluating old suppliers is an important step when it comes to establishing profitable relationships with suppliers. From a strategic point of view it is essential to find suitable suppliers that provide the business with products and material to an acceptable price. (Baily, 1997; Chen & Yang, 2003) The studied literature within the area of supplier evaluation is based on researchers from the eleven authors Weber et al. (1991), Baily (1997), Chen and Yang (2003), Monczka et al. (2005), Narasimhan et al. (2006), Şen et al. (2008), Lee and Drake (2010), Kahji and Shafaei (2011), Wu and Weng (2010), Ravindran et al. (2010) and Shen and Yu (2012). The authors have mentioned important sub-criteria when evaluating suppliers and these have been categorised in the three criteria; cost, service and delivery. A compilation over the authors conclusions regarding important sub-criteria are presented in Table 1 in the end of this chapter.

3.3.1 COST CRITERIA

It is not uncommon that net price is considered to be of top priority when choosing and evaluating vendors (Baily, 1997; Chen & Yang, 2003, etcetera). Traditionally most purchasers have found price to be one of the most important sub-criteria since the year of 1966 when Dickson (1966) carried out a compilation regarding the most important factors when selecting suitable suppliers. Weber et al. (1991) have continued Dickson (1966) studies with a more modern approach with similar results showing the net price should be prioritized as an important sub-criteria. It is however essential to not only look at the price but also to reflect on what the paid amount generates in form of factors like quality (Baily, 1997).

Another post that generates costs when establishing a relationship with a supplier is maintenance costs that occur when upholding an affair in form of transaction cost, vendor meetings etcetera (Narasimhan et al., 2006). Gaining a successful collaboration is worth working for because it creates opportunities to increase profit and lower costs in a long-term perspective (Saunders, 1997). A good collaboration could for example be used to lower inventory costs (Baily, 1997). Too much inventory is not good from an economic perspective because of the capital that it ties but too small levels can affect the production in form of shortage of material. (Monczka et al., 2005) Quality costs are linked to costs that appear to ensure that the purchased materials and products meet the demands set by the quality department. If there are several issues with a specific vendor this post will increase as a result of more controls. (Lee & Drake, 2010)

As a result of the globalisation trend companies are forced to seek different options to continuously reduce costs and keep a competitive market position. One common action is to outsource parts of the business to developing countries where the labour cost is lower. (Van Weele, 2012) The increased distance between a business and its vendors creates an increased
cost for transportation (Krajewski & Ritzman, 2002). Negotiations with both the suppliers and distributors are often necessary to manage a transportation system that can deliver goods in a preferred way (Monczka et al., 2005). The sub-criteria related to the cost criteria that should be taken into account according to the different authors, are presented in Table 1.

3.3.2 SERVICE CRITERIA

The service criteria includes several sub-criteria that all in some way reflects over possible improvements in the relationship between a buyer and a seller and the flow of products from one to another (Baily, 1997). When vendors are selected or evaluated, service aspects should be discussed in order to work proactive and assure that services are available if necessary (Saunders, 1997). What the vendor is able to offer depends partly on the production facilities and capabilities. With good working conditions in the production, a higher quality and flexibility can be expected why choosing well equipped vendors can be seen as a strategic decision. (Weber et al., 1991; Şen et al., 2008)

During supplier negotiations, the sub-criteria concerning payment terms and warranties are usually discussed. The customer wants to pay as late as possible to keep a high liquidity and the selling company wants to collect the payments as soon as possible for the same reason. Warranties are also discussed as insurance for the customer if something breaks or does not work as it is supposed to do. (Monczka et al., 2005) The opportunity to receive support services such as professional advice before and after a sale as well as technical assistant when needed can be highly valued when choosing suppliers (Baily, 1997). Weber et al. (1991) also pointed out the importance of technical assistants in form of repair services which can be critical if something breaks and leaves the production on hold until it is repaired.

A supplier’s capability to be flexible when it comes to order adjustments are other aspects that should be taken into account when vendors are evaluated. Sudden changes in demand can force a production to either produce more or less than expected. The vendor’s ability to adjust to a different volume is one factor that will affect how well the situation can be handled. Other kinds of modifications can also be necessary to keep the production going and holding an edge towards the competitors. (Lee & Drake, 2010; Mei-Ying & Yung-Chien, 2010; Shen & Yu, 2012) Long-term relations with vendors create trust and collaboration, which can increase the flexibility (Saunders, 1997). The sub-criteria within the service criteria that should be taken into account according to eleven authors are presented in Table 1.
3.3.3 DELIVERY CRITERIA

A useful criteria when negotiating with suppliers is the capability of delivery, which can reduce the stock levels and increase the inventory turnover (Mei-Ying & Yung-Chien, 2010). Delivery is the second most important criteria and it is essential that the orders are delivered on time. It is therefore essential to include negotiations concerning lead times when suppliers are evaluated. (Weber et al., 1991; Ravindran et al., 2010) Lead time is defined as the time from ordering until the goods are delivered. The reliability of the lead time is important both to minimise production stops and to minimise tie up capital in inventories. (Oskarsson et al., 2013) In addition to establishing a reliable lead time it is also essential to receive all the expected orders, otherwise the products are not useful (Mei-Ying & Yung-Chien, 2010).

During the negotiation with a vendor the volume of the orders are contracted (Monczka et al., 2005) and the minimum order quantity is specified before the contract is signed (Narasimhan et al., 2006). Another sub-criteria that should be considered before selecting suppliers are their geographical location. Dickson (1966) mentioned the importance of the supplier’s geographical location and in the author’s study it was ranked at place twenty among twenty-three possible. Even if it is ranked low, the sub-criteria is often mentioned which is the reason why it still should be evaluated. The reason is that it has been more important to purchase from more local companies. (Weber et al., 1991) The criteria delivery and its sub-criteria are presented in Table 1 according to eleven authors.
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To achieve and maintain a leading market position, companies have to focus more on activities related to purchasing. Establishing collaboration with suppliers which produce quality products, delivers on time, offers satisfying service and at a preferable low price is therefore essential. (Mei-Ying & Yung-Chien, 2010) Earlier, the purchasing staff’s main task was to reduce the material prices (Chen & Yang, 2003) but as the purchasing costs can account up to 70-80 percent of the product’s cost (Shen & Yu, 2012) it has become more important to look at the total costs when contracting with suppliers. The cheapest product can turn out to be the most expensive in the long run because of hidden costs that can arise with unsatisfied quality and bad delivery performance. (Chen & Yang, 2003) Temporary storage can therefore be necessary to have as a result of bad delivery performance from the suppliers (Oskarsson et al., 2013). Both different transportation- and inventory options will be presented more below.

3.4 TRANSPORTATION- AND INVENTORY OPTIONS

It has been proved that many different parameters should be evaluated when selecting and evaluating suppliers. The awareness of which criteria that matters and affects a business general success creates an opportunity to work proactive and negotiate in a suitable way (Saunders, 1997). Companies that are searching for cheap net prices tend to purchase from actors on the international market, which demand more transportation of the goods (Van Weele, 2012). Neglecting to take this cost into calculation when choosing suppliers results in a deal that might not be as profitable as expected (Baily, 1997). Theories concerning transportation options will therefore be presented below. The fact that net price is a highly valued sub-criteria according to Table 1, makes it interesting to investigate the consequences of buying expensive versus cheap products and materials. In addition to the actual investment cost, the product’s value has an impact on how much capital that is tied up in inventories. Different inventory options will therefore also be included in this chapter.

3.4.1 TRANSPORTATION OPTIONS

Due to the increased globalisation, many companies have decided to move their productions to developing countries as a way to obtain lower costs (Van Weele, 2012). Purchasing products from outside EU means a custom cost will be added to the transportation cost (Tullverket, 2016a). The enhanced transport cost has resulted in new requirements regarding suitable modes of transportation (Björklund, 2012). Even though companies have taken actions in order to keep the costs reasonable they tend to keep growing. Nowadays it is not uncommon that more than the majority of the companies’ money spent on logistic activities is spent on transportation. Customers’ higher demands for fast deliveries and sustainable solutions increase the pressure on companies to create an effective system from both a time and economic perspective. Because transportation is costly for companies, an effective system can lower costs and provide competitive advantages. (Coyle et al., 2013)
Choosing which mode of transportation that is suitable can be quite difficult. According to trends higher transportation frequency, reduced lot sizes and higher quality are aspects that companies today try to obtain. The huge amount of possibilities regarding vehicles and modes of transportation create a complex market where more factors have to be taken into calculation in order to decide which solution is the best. (Nilsson, 2000) In Figure 7 below, several aspects that should be evaluated when choosing transportation options are presented.

The four most common transport alternatives are by airplane, truck, boat and railway. Depending on factors like weight, volume, infrastructure, delivery reliability, distance, sensitively and the goods' value, different modes of transportation are suitable. In general, heavy and large orders are transported by boat or on railways while light and small orders are preferably transported by trucks or in some cases airplanes. (Björklund, 2012) Usually there are at least two different choices when deciding mode of transportation. Using transhipments to combine different modes of transportation are the most common choice as it often provides the most cost effective solution. As a consequence from choosing the cheaper alternative, positive environmental effects will often be provided. (Pewe, 2002) The potential and restrictions concerning the different modes of transportation act as underlying information when a distribution solution is established, why more information regarding transportation modes is relevant. As a consequence of the given directives presented in chapter 1.3 – Directives only truck-, air- and sea transports will be evaluated as possible modes of transportation and these will be presented below.
TRUCK TRANSPORT

The development of the road transportation system and trucks’ growing loading capacity are some of the reasons why trucks today are the most common mode of transportation within reasonable distance (Pewe, 2002). As companies today experience higher pressure on fast deliveries containing small orders, truck transport are an attractive option because the frequency of deliveries can be kept high. With a higher transportation frequency, each order contain fewer articles which means the tied up capital in pipeline inventories is reduced. (Björklund, 2012) Time sensitive articles which are suitable for truck transports include electronics, electrical machinery, automotive parts and other finished and semi-finished goods. Apart from the time aspect these kind of articles demand superior protection in-transit, why trucks are suitable. (Coyle et al., 2013) Furthermore, the mode of transportation offers not just speed but flexibility as well. The ability to transfer goods directly from the supplier to the customer without having to spend a lot of time with transhipment leads to reduced cost and less damage on the goods. The costs for transhipment are therefore low because of the limited need for transhipments. Another consequence is the low costs for terminals because transhipment is not always necessary. (Pewe, 2002)

On the negative side, the frequent deliveries are expensive as each truck has limitations on the loads. With an increased distance the costs also increase, why the loading capacity is essential for the suitability to transporting goods a long distance by using trucks. (Pewe, 2002) The development of different kinds of trucks with specific capacity has increased the possibility to carry load contra speed and flexibility. However, even the largest trucks cannot compete with either boats or trains in regard to loading capacity. (Coyle et al., 2013) Having vehicles travel in a high frequency also have a negative impact on the environment. The trucks are also limited to the existing road infrastructure and traffic, which means that they cannot always travel as fast as planned. (Pewe, 2002) A summary of the advantages and disadvantages with truck transports are presented in Figure 8.

![Figure 8: The advantages and disadvantages with truck transports (Inspired and translated from Pewe, 2002, p.125).](image)
AIR TRANSPORT

Obtaining purchased goods from a far distance is usually done by either shipping or flying. Traditionally, air transportation has been viewed as an expensive alternative that only should be used in emergencies. Because of increased pressure regarding reducing inventories and order cycle time, air transportation is now quite popular. (Coyle et al., 2013) Because of the correlation between transport cost and weight, only low-weight and high value orders are preferred for air transportation (Björklund, 2012; Nilsson, 2000). Furthermore, aircrafts only have a certain amount of space, which means that voluminous goods or big order quantities have to be planned in advance to acquire a smooth flow. The big negative environmental impact should also be taken into account before choosing air transportation. (Pewe, 2002) Because of the limited space on airplanes, the environmental impact per article are high in comparison to other modes of transportation (Ammenberg & Hjelm, 2011)

The main reason why air transport is so popular is the speed, which enables flexibility (Björklund, 2012). As the fastest mode of transportation, companies can collect purchased material from all over the world. However, action has to be taken to ease the transhipment to trucks at airports to gain the benefit of fast deliveries. (Pewe, 2002) A consequence of quick deliveries is that the capital is not tied in pipeline inventories during a long time, which is positive from an economic perspective (Krajewski & Ritzman, 2002). A short transport lead time is often preferred for expensive products because of the capital it ties up, which makes a long transportation time more costly (Björklund, 2012). The cautious handling of air goods generates a lower risk for damage during the flight, which reduces the necessary level of packaging material. The cost for packaging material to protect the goods during transportation is therefore also reduced with air transportation. (Pewe, 2002) A summary of the advantages and disadvantages with air transport are presented in Figure 9.

Figure 9: The advantages and disadvantages with air transport (Inspired and translated from Pewe, 2002, p.262).
SEA TRANSPORT

When the distance between a vendor and its customer is too long for a truck to transport the goods within a reasonable time span, sea transportation can be a suitable option. Heavy orders are usually too expensive to send by airplanes why boats are a better option. (Pewe, 2002) The capability to transport low-value, high-density, bulk cargoes over the seas have led to approximately half of the international transport revenue are represented by sea transports (Coyle et al., 2013). By being independent of roads or railways, a ship can travel freely on the oceans. The only infrastructure that is needed to accomplish a successful travel is the arrival and departure from harbours. Loading goods into containers also lowers the risk of damage and local thievery. (Pewe, 2002)

Even though sea transports often are preferred as mode of transportation of heavy goods bought from a far distance, it is not always a possible option. If there are not any close connections to harbours, other options must be evaluated. (Björklund, 2012) Because of the limited speed on the boats and the transhipments, sea transport is classified as a slow mode of transportation (Pewe, 2002). Long transport lead times generate high pipeline inventory cost as the capital is tied up and cannot be used or invested in other affairs. Products with a high value are therefore not optimal to transport by ship. (Björklund, 2012) Other cost that should be taken into calculation when deciding if sea transport is suitable are the cost organising terminals and the handling of goods which are usually quite expensive (Pewe, 2002). Although its limitations, water carriers provide huge capacity per vessel. To compare, one barge hold as much freight as 15 rail cars or 60 trucks. (Coyle et al., 2013) A summary of the advantages and disadvantages with sea transport is presented in Figure 10.

Figure 10: The advantages and disadvantages with sea transport (Inspired and translated from Pewe, 2002, p.215).
3.4.2 INVENTORY OPTIONS

Inventory levels are a well-discussed subject that often divides employees’ opinions depending on their positions in the company. From an economic perspective, inventories should be as low as possible to raise the company’s liquidity. In contrast, people working close to the production think it is more important to never get shortage of material because it could lead to production stops. From that point of view, inventory levels should be high enough to minimise the risk of shortage. (Oskarsson et al., 2013) Traditionally, high inventory levels were standard as it was an accepted practise for many years. The growing insight in the subject has however led to a reduction of inventory levels, as there is a big amount of money to save by managing the stocks more effective. It was also realised that high inventory levels often hid other problems, such as bad product quality, which further increased the motivation to put more effort into making a difference. (Monczka et al., 2005)

Companies keep inventories in order to offer their customer satisfying service. The better the service the higher the inventory levels have to be. Different kinds of inventories are set up in order to handle uncertainties both within the company and from the surroundings. (Oskarsson et al., 2013) High inventory levels are preferred to minimise the risk for stock outs (Coyle et al., 2013). However, high availability are costly as it ties up capital that could come to better use in other parts of the company (Krajewski & Ritzman, 2002). A description regarding different inventory options and relevant equations for calculating inventory costs will follow.

CYCLE- AND SAFETY STOCK

The products that are stored and consumed between two incoming deliveries are part of a cycle stock. A cycle stock therefore varies in stored quantity and it reflects the demand during a specific time period. However, in order to reduce the risk for shortage a cycle stock is not enough as it only stores as much products that are expected to be consumed until the next incoming delivery. Safety stocks are therefore set up to in a proactive manner handle incidents and uncertainties such as delayed incoming goods, unsatisfying product quality or if the customer’s demand suddenly increases. (Oskarsson et al., 2013) A high safety stock creates an enhanced opportunity to manage customer’s order in exchange for extra costs (Lambert et al., 1998). Attempting to foresee and guard against all possible events are however a complex and expensive matter. The inventory level displays how many products that are stored and therefore consist of both the safety stock and the cycle stock. (Oskarsson et al., 2013)

In order to calculate the cost for storing products in inventories, a momentary insight can be gained by applying Equation 1. Based on the company chosen interest rate, the value of the stored goods and the average stock level, an inventory cost can be visualised. The interest rate gives indications on the product’s capital- and risk costs, which typically are costs for scrapping and damage on the goods. The products’ values are determined by its net prices.
Furthermore, the average stock level depends both on the quantity of products that are stored in the safety stock and the average level of the cycle stock. (Oskarsson et al., 2013)

Equation 1: The equation to measure the costs for having inventories (Oskarsson et al., 2013).

\[ \text{Stock cost} = r \times p \times ASL = r \times p \times \left( SS + \frac{Q}{2} \right) \]

- \( r \) = interest rate
- \( p \) = net price
- \( ASL \) = average stock level
- \( SS \) = safety stock
- \( Q \) = order quantity

PIPELINE INVENTORY

During the transportation time, the products tie up capital in the pipeline inventory until they arrive to the next facility in the supply chain (Krajewski & Ritzman, 2002). An equivalent term is mentioned by both Coyle et al. (2013) and Lambert et al. (1998) but they call it an in-transit stock instead. The meaning is still the same, and Coyle et al. (2013) stated that in-transit inventory cost increases in correlation to transportation lead time. Choosing fast modes of transportation are consequently more preferable from a pipeline inventory perspective. (Coyle et al., 2013)

To give an insight in the inventory costs during the transportation, a calculation over the pipeline inventory is useful. Equation 2 visualises how to calculate the pipeline inventory and it is based on transportation lead time and the average demand during the period. (Krajewski & Ritzman, 2002) Coyle et al. (2013) mentioned the longer the transportation lead time is, the higher will the cost be for having the products in storage. According to Baily (1997) the inventory levels need to be increased when the transportation lead time is long to ensure that the production can continue even if something unexpected were happen.

Equation 2: The equation to measure the pipeline inventory (Krajewski & Ritzman, 2002).

\[ \text{Pipeline inventory} = d \times L \]

- \( d \) = average demand per period
- \( L \) = transportation lead time
CONSIGNMENT STOCK

A consignment stock is another inventory option where the vendor owns the stock until the customer extract products from it. The inventory is situated in the customer’s warehouse and the benefit for the customers is the high availability which they only pay for once the products have been consumed. (Zanoni et al., 2014) When a company applies this kind of inventory option, the vendors receive continuous updates concerning the stock levels in order to determine when the stock needs to be refilled. Consignment stocks are profitable for products defined by high demand variations, limitations of inventory spaces and risk of obsolescence (Battini et al., 2010a). According to Corbett (2001) a consignment stock is preferable when the supplier has long production cycles. The costs for consignment stocks are lower and therefore more profitable for the whole supply chain than the traditional approach with fixed re-order points (Battini et al., 2010a).

In addition to the fact that the money is not tied up in consignment stocks, another advantage is the buyer does not have to think about over- and understocking of inventory levels (Zanoni et al., 2014). With a consignment inventory there are bigger chances to avoid shortages of material and it reduces management costs related to ordering and handling fluctuating demands (Battini et al., 2010a). The benefits for the customer, when implementing consignment stocks, are reduced management costs, the transport lead times are as good as eliminated, materials are always available and they only have to pay for the direct used material. In order to create a successful consignment stock solution, a deep and long relationship with the supplier is necessary. Compatible systems, such as EDI or on-line data update, are also required for a profitable set up. (Battini et al., 2010b)
4 PROBLEM SPECIFICATION

This section begins with a general problem specification where the foundations to the problem are described. The studied system is thereafter defined, followed by a presentation of the chosen limitations. A decomposition of the purpose is presented and it generates several research questions, which will be answered in the study.

4.1 GENERAL PROBLEM SPECIFICATION

Control Product’s purchasing function consists of two purchase departments, based on operative respective strategic activities. These activities can be compared with the purchase process, presented by Van Weele (2012), when the strategic purchasers are conducting tactical purchase while the ordering function is related to operative activities. When the strategic purchasers negotiate with suppliers they determine a setup which includes factors such as distribution and inventory management. The operative purchase department then has to adjust to the foundation of sub-criteria when placing orders. The material planners, working at the operative department, also have to avoid shortage of material as it would cause production stops. If inventory levels are alarmingly low, the employees working in the production inform the material planners of the situation. After passing through the unit’s production processes, the refined products are distributed to the customers. (Material planners, 2016) The connection between involved actors is presented in Figure 11. Because of different goals and pressures, the negotiated sub-criteria between strategic purchasers and suppliers are not necessary the best choice from a wider perspective. By understanding the affect the negotiated contracts have on the different actors, suitable areas for improvements can be detected.

Figure 11: An overall illustration over which actors that are affected by the negotiated contracts.
Previous conducted research has shown that in addition to net price, it is also important to take transport- and inventory costs into consideration when suppliers are selected or evaluated (Baily, 1997; Monczka et al., 2005; Lee & Drake, 2010; Kahji & Shafaei, 2011). Because the strategic purchasers at Control Products focus primarily on net price, the added costs for transportation and inventories have not been fully evaluated. This results in costs that are determined by the negotiated agreement between the strategic purchasers and the suppliers, but financed by the operative purchase department. (Logistics & material manager, 2016) Evaluation of the purchase-, transport- and inventory costs together is therefore seen as a plausible way to accomplish more profitable deals.

The globalisation trend has influenced how companies collect purchased material and where it is bought from. Buying products from all over the world with the aim to find the cheapest net price has been necessary for companies to stay competitive. (Van Weele, 2012) The low net price is an attractive factor but as stated by Coyle et al. (2013) it is important to take the increased transportation costs into account to receive truthful analyses. Furthermore, a similar situation exists when it comes to inventory management. Monczka et al. (2005) argue that the traditionally high inventory levels have become unacceptable as it ties up too much capital. Some inventories will however always be necessary to keep up the customer service, why the balance between suitable inventory levels is a complex question (Oskarsson et al., 2013). In order to gain an insight about a setup’s suitability in regard to choose suppliers, mode of transportation and inventory options, an investigation regarding the correlation between purchase-, transport- and inventory costs is required.

By investigating how the purchase-, transport- and inventory costs affect each other and whether or not it would be suitable to include all cost posts in future negotiations, four different cases will be studied. Each case consists of one specific article that will be evaluated based on both its current situation and alternative scenarios. By calculating the purchase-, transport- and inventory cost for each of these four cases, conclusions can be drawn regarding the cost posts’ correlation. In order to determine which articles that would be suitable examples to investigate and exactly which costs that will be included, a studied system is defined on the next page.
4.2 STUDIED SYSTEM

To limit the project and focus on aspects that can be influenced and altered during a near time period a studied system has been defined. According to Krajewski and Ritzman (2002) costs can be reduced by collaboration throughout the entire supply chain. By not only include Control Product’s suppliers but also their suppliers’ suppliers, the impact of the production lead time will further be investigated. The way the goods are distributed between the suppliers is however excluded from the studied system because Control Products holds no impact over the decision. The study will neither include the suppliers’ production or inventory management except for the time it takes for the suppliers to finalise an order. The distribution from the suppliers to Control Products will be part of the study, as the unit often stands accountable for the transport cost. How the transportation lead time affect the pipeline inventory costs will also be investigated in the study. Purchase cost occurs when purchasing from suppliers. If the suppliers are situated outside EU a custom cost will also arise (Tullverket, 2016a). Both the purchase- and custom cost will therefore be included in the studied system. When the products are placed in inventories at Control Products the products tie up capital which generates a stock cost.

Both the strategic and operative purchase departments at Control Products are included but activities concerning its production and outbound transportation to the customers are excluded. The reason is that the conclusions will not change how the unit produce or deliver goods to their customers. How the studied system is defined and which costs that are included in the study are presented in Figure 12. The following chapter explains further, in form of limitations, which aspects that are excluded from the study.

Figure 12: The figure visualises the studied system that is investigated in the research.
4.3 LIMITATIONS OF THE RESEARCH

By defining some limitations to the study, in addition to the directives for the study, the research became more manageable based on the available scope of time. The compiled limitations have all been discussed and decided in coherence with the supervisors from both the university and the company.

To fulfil the study’s purpose, the studied setups have to be plausible for Control Products to implement. Aspects that cannot, within a reasonable amount of effort, be altered by the unit itself will therefore be excluded from the study. According to chapter 2.4 – *Inbound transportation at ABB* there are two different ways to determine how the transportation of goods will be performed. The most common alternative is when ABB handles all decisions related to transportation, which is called *Financial Conduct Authority*, FCA. The other alternative is that the supplier handles the entire distribution and the net price will then include the distribution service. Because Control Products cannot affect the transport management with the second alternative, all suppliers with that kind of contract will not be evaluated in this study. The first limitation is therefore defined as:

- **Limitation 1: The research will only include transportations, which are categorised as FCA.**

One negative aspect with sea transportation is the high costs for organising terminals and handling goods at harbours. A similar problem is detected for air transportation, as the goods often have to be transhipped into trucks to finalise the delivery. (Pewe, 2002) These costs are however included in the invoices sent by the distributor who delivers the goods to the production site, why a specific investigation concerning how the goods are handled at harbours and airports will not be included in this study.

- **Limitation 2: How the goods are managed in harbours or on airports are not included in the research.**
4.4 RESEARCH QUESTIONS

In order to establish more manageable research questions, a decomposition of the purpose has been done. The purpose is presented below, followed by a description regarding what the coming chapters will include.

The study’s purpose is to recommend future guidelines for the strategic purchasers at ABB’s unit Control Products that can be applied when negotiating with suppliers, by evaluating purchase-, transport- and inventory costs.

According to the Logistics & material manager (2016) the costs for transport and inventories that are arisen at the operative department are affected by the setups negotiated by the strategic purchasers. Except for the purchase cost, the transport- and inventory costs might also be important to take into consideration when select and evaluate suppliers. Four concrete cases have been defined to exemplify how the purchase-, transport- and inventory costs are affected by different setups.

Specific articles will be analysed in form of cases in order to determine how the cost posts varies depending on both their current situation and alternative scenarios. Establishing which articles that are suitable as case representatives will be determined in the following subchapter. Once the cases have been defined, main research questions have been created in order to investigate how the cases’ purchase-, transport- and inventory costs are effected by different setups. More detailed subqueries have also been defined to enable answering the main research questions. The chapter ends with a main research question related to the effect different setups have on both the divided and the summarised purchase-, transport- and inventory costs.

4.4.1 DEFINING CASES

Net price is viewed as the most important sub-criteria when the strategic purchasers selects and evaluates suppliers. The lead time is also of importance because of its effect on other actors in the supply chain. The transport lead time from the supplier can be short at the same time as the suppliers’ production lead time might be long as a result of the time it takes to order and produce components. (SCM manager respective Logistics & material manager, 2016)

Based on the literature review, presented in chapter 3.3 – Supplier evaluation, the sub-criteria concerning lead time was the only one mentioned by all the eleven authors presented in Table 1. At second place came the net price, which was mentioned by all authors except for one. This result indicates that out of all studied sub-criteria these two are the most important ones to take into calculation when vendors are chosen or evaluated. (Weber et al., 1991; Baily, 1997; Chen & Yang, 2003; Monczka et al., 2005; Narasimhan et al., 2006; Şen et al., 2008; Lee & Drake,
Profitable negotiations

2010; Kahji & Shafaei, 2011; Wu & Weng, 2010; Ravindran et al., 2010; Shen & Yu, 2012) Furthermore, Nilsson (2000) mentions that transportation lead time and the product’s value are relevant sub-criteria when choosing a suitable mode of transportation. From an inventory perspective, the net prices are of importance as expensive articles tie a lot of capital. Because the transport lead time has a direct correlation with the pipeline inventory cost and the general risk, it is also an important sub-criteria for inventory management. (Coyle et al., 2013)

Because both the studied theories and the unit’s employees agree that lead time and net price should be negotiated about, they have been chosen to set the foundation for the specific articles that will represent different cases in this study. Four different property combinations can be created by varying long and short lead time and high and low net price. Discussions with the unit’s SCM manager respective Logistics & material manager (2016) resulted in case one and case two shares the same article properties in regard to lead time and net price. The reason was that the combination with long lead time and high net price was extra relevant to analyse due to eventual up-coming contract changes. In addition to the variating properties, the chosen articles also have different setups. A setup defines the way the collaboration between Control Products and a supplier is designed. Factors such as where the goods are purchased and distributed from, what kind of mode of transportation that is used and how the inventories are managed is what defines a setup. The four cases and the respective article are presented in Table 2.

Table 2: A presentation over the chosen case foundations, where the lead time and the net price are the sub-criteria that varies. The specific articles are also defined.

<table>
<thead>
<tr>
<th>Case</th>
<th>Lead time</th>
<th>Net price</th>
<th>Chosen article</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>Long</td>
<td>High</td>
<td>Circuit board</td>
</tr>
<tr>
<td>Case 2</td>
<td>Long</td>
<td>High</td>
<td>Thyristor</td>
</tr>
<tr>
<td>Case 3</td>
<td>Short</td>
<td>High</td>
<td>Thermosetting resin detail</td>
</tr>
<tr>
<td>Case 4</td>
<td>Short</td>
<td>Low</td>
<td>Thermosetting resin detail</td>
</tr>
</tbody>
</table>

The four defined cases will in this study be investigated based on purchase-, transport- and inventory costs and the research questions related to each of the costs will be described in the following subchapters.
4.4.2 PURCHASE COST

Defining specifications and establish a collaboration with suitable suppliers are the main work assignments that are included for the purchasing function’s tactical department. Depending on which deals that are negotiated with suppliers, collaboration can be more or less profitable. (Van Weele, 2012) It is not uncommon that companies spend more than half of their profit on purchasing material to keep the production going (Lambert et al., 1998). The purchasing function’s influence in regard to choosing which deals and suppliers to accept gives a lot of power over a company’s economical result (Van Weele, 2012). Net price is a sub-criteria that previous conducted researches have shown to be generally prioritised when selecting and evaluating suppliers (Weber et al., 1991; Baily, 1997; Chen & Yang, 2003; Monczka et al., 2005; Narasimhan et al., 2006; Şen et al., 2008; Lee & Drake, 2010; Kahji & Shafaei, 2011; Wu & Weng, 2010; Ravindran et al., 2010; Dickson, 1966). As a consequence of the increased global competition, companies are forced to continuously develop their business and find alternative ways to lower costs (Saunders, 1997). In order to lower cost related to purchase, finding and choosing suppliers that can offer the lowest net price are therefore a popular course of action (Van Weele, 2012).

The strategic purchase department at Control Products negotiates with both new potential suppliers as well as current ones. With a main focus on the sub-criteria net price, the strategic department aims for a yearly net price reduction of five percent. In order to achieve this goal different setups have been applied, for example replacing suppliers and start purchasing more from Asia as they can offer lower net prices. (Strategic purchasers, 2016) Based on the department’s performed activities, it corresponds to tactical purchase that is described by Van Weele (2012). The strategic purchase department set specifications, choose suitable suppliers and signs contracts with them (Strategic purchasers, 2016). How the purchase cost, which is determined by the net price and the ordered quantity, is affected by the setup choices determined by the strategic purchasers are therefore essential to investigate further. The main question is defined as follows:

**Q1:** How is the purchase cost affected by different setups?

In order to answer the main question, different setups have to be studied to enable conclusions to be drawn. Based on the four different cases that have been defined on their variation in regard to articles’ properties and setups, an investigation concerning both their current and alternative purchase cost will be performed. The following subqueries are therefore:

**Q1.1:** What is the current purchase cost for respective case?
**Q1.2:** What would purchase cost be for the cases’ alternative scenarios?
In addition to negotiating about net prices, the strategic purchase department at *Control Products* also creates a sub-criteria foundation that the material planners at the unit’s operative purchase department have to adjust to. Transport- and inventory costs are two areas that are determined by the strategic purchasers but financed by the operative purchase department. How these cost posts are affected by different negotiated setups are therefore interesting to investigate further.

### 4.4.3 TRANSPORT COST

In general, companies’ transport cost has grown lately as a result of increased purchasing from the international market. By purchasing products from developing countries, better prices can be gained which often tend to compensate for the increased transport cost. (Van Weele, 2012) *Control Products* is no exception as the unit purchases articles from countries both located in Asia and Europe. Looking at the inbound transportation an increased cost trend has been identified as a result of growing collaboration with suppliers located outside Sweden, see Figure 5 in subchapter 2.4 – *Inbound transportation at ABB*. (Logistics & material manager, 2016) Because the focus has mainly been on the outgoing transportation, both the current and alternative transport costs regarding the inbound transportation have not been properly evaluated (Freight manager, 2016). To investigate if the transport cost is essential to take into consideration when choosing suitable vendors it is important to evaluate how different setups, such as where to buy from or how to transport the goods, affect the transport cost. The main question is therefore defined as:

**Q2: How is the transport cost affected by different setups?**

To decide which mode of transportation that is suitable, several aspects have to be taken into account. Different properties such as value, weight and subventions help define limitations regarding which options that are possible and which are not. (Nilsson, 2000) Depending on which mode of transportation that is chosen sub-criteria such as cost, transportation time and risk will vary. It is not uncommon that speed and low risk are prioritised instead of cost (Björklund, 2012). However, in the conducted literature review, presented in chapter 3.3 – *Supplier evaluation*, several actors noted transport cost as an important sub-criteria to take into account when choosing and evaluating suppliers (Baily, 1997; Monczka et al., 2005; Kahji & Shafaei, 2011). From an economic perspective different modes of transportation are often more suitable than if time is the prioritised sub-criteria. For example is sea transportation a cheap alternative but very slow in comparison to air transport that tends to be expensive but fast. (Pewe, 2002) The choice concerning transportation mode is often based on traditional options that have not been challenged or further investigated. The high usage of air transportation from Asia has been criticised as expensive but it is still motivated because of the short lead times. (Strategic purchasers, 2016; Freight manager, 2016)
In order to answer to the main question, the current transport cost for the four different cases has to be compared with alternative scenarios from an economic perspective. The following subqueries are therefore defined as followed:

**Q2.1:** Which mode of transportation is currently used for respective case?
**Q2.2:** What are the current transportation costs for respective case?
**Q2.3:** Which modes of transportation would be plausible for the cases’ alternative scenarios?
**Q2.4:** What would the transportation costs be for the cases’ alternative scenarios?

Depending on whether or not articles are bought from inside or outside EU, customs have to be paid in addition to the freight charge. All invoices regarding transportation are directed to the operative purchase department why a reduction of transportation cost would benefit the department’s result. (Trade operations manager, 2016) By investigating how the custom cost would vary depending on negotiated setups, it can be determined whether or not it should be taken into account when the strategic purchasers select and evaluate suppliers. The upcoming subqueries to investigate this further are:

**Q2.5:** What are the current costs of custom for respective case?
**Q2.6:** What would the custom cost be for the cases’ alternative scenarios?

According to Krajewski and Ritzman (2002) different modes of transportation also affect the inventory levels and the related costs. The impacts different setups have on the inventory costs will therefore be investigated by the research questions presented in the next subchapter.

### 4.4.4 INVENTORY COSTS

As an intervention against increased inventory levels, *Control Products* has initiated actions to reduce costs for inventories (Inventory specialist, 2016). The way the strategic purchasers negotiate with suppliers and achieve reduced net prices on the products might bring higher costs for the operative department (SCM manager respective Logistics & material manager, 2016). In order to determine the plausible affect the negotiated setup has on the unit’s inventory costs the following main question has been defined as:

**Q3:** How are the inventory costs affected by different setups?

Because of the risks of production stops, the material planners are ordering enough products to ensure a low risk for shortage (Material planners, 2016). The tendency to order materials so the risks are always considered to be low creates high inventory levels (Inventory specialist, 2016). Oskarsson et al. (2013) mentioned this as a typical reaction that appears when working near the production. According to Krajewski and Ritzman (2002), the high product availability generate both high inventory levels and costs. The traditional acceptance for high inventory
levels has however been replaced after insights about possible profits from managing stocks more effectively (Monczka et al., 2005). The tied up capital in inventories can be used somewhere else in the company (Krajewski & Ritzman, 2002) and to calculate the costs Oskarsson et al’s. (2013) stock cost equation can be applied.

Air transportation is classified as the fastest mode of transportation and it enables worldwide purchasing of material without long transport lead times. The usage of trucks also generates high speed compared to the slow mode of transportation with boats. (Pewe, 2002) Coyle et al. (2013) stated that higher inventory levels are needed for the increased uncertainty with long transport lead times. Different mode of transportation can therefore affect inventory levels and the stock costs will therefore be investigated. By calculating the inventory costs, a further insight in companies’ current economic situation is provided (Oskarsson et al., 2013). Consequently, the following subqueries concerning stock costs are defined below.

Q3.1: What are the stock costs for the current situation for respective case?
Q3.2: What would the stock costs be for other alternative scenarios for respective case?

Depending on chosen mode of transportation, the distributed material ties up capital during a varying time period (Björklund, 2012; Pewe, 2002). It can be economic beneficial to reduce the transport lead time, which would minimise the tied up capital during the transportation. The pipeline inventory can be measured by multiply the transport lead time with the demand for the products during the period (Krajewski & Ritzman, 2002) Oskarsson et al. (2013) presented the equation to measure the stock costs, which is based on the average level on the stock. The costs for pipeline inventory are a combination of the two equations into one, which can be used to measure the tied up capital for the products during an average day during the year. Equation 3 presented below, will help to calculate the pipeline inventory costs.

Equation 3: The equation for pipeline inventory costs (Inspiration from Equation 1 and 2, 2016).

\[
\text{Pipeline inventory cost} = \frac{r \times p \times \bar{Q} \times L \times \text{number of deliveries}}{365}
\]

\[r = \text{interest rate}\]
\[p = \text{net price}\]
\[\bar{Q} = \text{average order quantity}\]
\[L = \text{transport lead time}\]

The pipeline inventory costs will be different depending on the transport lead time. Boat transportation will cause long transport lead time, while trucks is a fast alternative (Björklund, 2012). In similarity, transportation by air will also only tie up limited capital as a consequence of the fast transportation (Krajewski & Ritzman, 2002). What the pipeline inventory costs would be for the current situation and the alternative scenarios will therefore be investigated and the related subqueries are:
Profitable negotiations

Q3.3: What is the current cost for the pipeline inventory for respective case?

Q3.4: What would the cost for the pipeline inventory be for the cases’ alternative scenarios?

The affect both the divided and the summarised purchase-, transport- and inventory costs would have on different setups will be investigated with the main question presented in the following subchapter.

4.4.5 ANALYSES

The strategic purchasers are pressured to reduce the net prices on the products in order to reach the yearly goal to reduce the net price with five percent (Strategic purchasers, 2016). However, from an economic perspective the net price is not the only sub-criteria of importance when choosing suppliers according to the theories. It has been detected that transport- and inventory costs also are important to take into consideration when evaluating and selecting suppliers (Baily, 1997; Monczka et al., 2005; Lee & Drake, 2010; Khaji & Shafaei, 2011). As the strategic purchasers negotiate with suppliers they determine setups that affect the operative purchase department by costs related to transport- and inventory costs (Logistics & material manager, 2016). The consequences of the negotiated setups are increased costs for transportation the last year, see Figure 6 mentioned in subchapter 2.4 - Inbound transportation at ABB and also high inventory levels according to the Inventory specialist (2016).

In the subchapters presented above, main questions and subqueries will help to analyse purchase-, transport- and inventory costs for the defined example cases. A current situation will thereafter be presented together with the costs for each of the example cases. To be able to investigate how other setups would affect the costs, alternative scenarios to each of the case will be analysed and the related costs calculated. The setups will firstly be analysed in a divided view when the different alternative scenarios give indications on how the purchase-, transport- and inventory costs are affected. Thereafter, a summarised view might give indications whether the strategic purchasers also should take transport- and inventory costs into consideration when negotiating with suppliers. The defined main question to answer the purpose of this research is as follows:

Q4: Would Control Products benefit from extending their current focus on purchase cost to also include transport- and inventory costs in future supplier negotiations?

All the main questions and their subqueries presented in this chapter are presented in Appendix 1.
5 METHOD

This section presents the method used in the research. Firstly, the type of study will be described followed by a presentation over the study’s three phases. The methods used to answer research questions are then presented. Credibility and criticisms of the method are described in the final parts.

5.1 TYPE OF STUDY

While doing a case study it is significant to decide if the study should be investigating the reality as it is today or if it should aim to make changes in given parameters to try to improve the reality. It is also important to decide whether the study should be based on qualitative or quantitative research. (Lekvall & Wahlbin, 2001) The difference between these options is that a qualitative study is based on information that cannot be expressed in numbers as opposed to a study based on quantitative data where numbers and figures are used to analyse a specific situation. (Lekvall & Wahlbin, 2001; Lantz, 2013) To be able to fulfil the purpose with the study at ABB a combination of a quantitative and a qualitative approach have been used. Being placed at the LBU’s office in Västerås has provided the opportunity to work in collaboration together with relevant people at the same time as observations have been made during a time period of 20 weeks. Being present, making observations and working with limited time and resources indicated a qualitative approach (Hancock & Algozzine, 2011). Access and usage of quantified data indicate a quantitative approach (Lekvall & Wahlbin, 2001; Lantz, 2013).

5.2 COURSE OF ACTION

To acquire the study’s structure the course of action was initially determined and followed throughout the project. In order to keep it on track, some deadlines were decided in coherence with student opponents and the supervisor from the university. The study was divided into three phases based on deadlines and what had to be done in the different parts of the project.

During the initial planning phase, which was conducted for circa eleven weeks, the assignment of the project was presented during a meeting with the two students and the SCM manager respective Logistics & material manager (2016). Several meetings were held to concretise the project and to specify a purpose. Information regarding how the unit handles their daily work in regard to purchase was then collected and it is defined under section 2 – Company presentation. Relevant research material was then studied to gain a better understanding about purchase, relevant negotiating factors and transportation- and inventory options. The gathered information was compiled and it is presented in section 3 – Theoretical framework. In order to answer the study’s purpose, several research questions were defined with the help from theories. The problem was also defined together with the studied system. All information regarding the specification of what this study would investigate is presented...
in section 4 – *Problem specification*. As a final step in the planning phase, the method to answer the compiled research questions is presented in section 5 – *Method*.

The four weeks data collection phase included information gathering and calculations regarding both the cases’ current situation and their alternative scenarios. Data such as stock levels, net prices and mode of transportation were collected in order to calculate the yearly transport cost for each article and also the stock- and pipeline inventory costs. The purchase costs were also determined in the study. Several sensitivity analyses were conducted during the data collection phase where approximated parameters were investigated further to determine their impact on the presented result. By collecting data regarding both the current situation and alternative scenarios a comparison between the options were enabled.

During the three weeks when the analysis phase was conducted, information was analysed from both a theoretical and empirical perspective in order to answer the research questions, defined in chapter 4.4 – *Research questions*. Starting with analyses regarding each case separately, the calculations and its result could be analysed. In order to answer the study’s purpose and answer whether or not *Control Products* should take transport- and inventory costs into account when negotiating with suppliers, section 6 – *Case presentations and analyses* was concluded with *Case analyses* for the respective cases. The correlation between purchase-, transport- and inventory costs and how they are affect by different setups will be found in chapter 6.5 – *Final analyses*. The sections and chapters that the different phases include are presented in Figure 13 below followed by more specific information regarding how the information has been collected for the three phases. After the analysis phase was finished, two weeks were spent on writing abstract, conclusions and discussions. The report was also refined and presentations were prepared. In total, the project time amounted to 20 weeks.

![Figure 13: An illustration over where the information from respective phase is presented in this report.](image-url)
5.2.1 PLANNING PHASE

During this phase, all necessary information regarding how the unit handles purchase and relevant research were collected through interviews and relevant literatures. Section 2 – Company presentation was compiled by interviewing employees at both the operative- and the strategic purchase departments. Section 3 – Theoretical framework was inspired by the insight that the interviews brought concerning how Control Products handles their purchase. Through literature reviews, relevant theories from several different authors were collected. Based on both the interviews and the literature reviews the study could be further specified. Presented in section 4 – Problem specification there is a thorough description regarding what will be included and excluded from the study. Continuous interviews with supervisors from both ABB and Linköping University were held to define the aim of the study and to make sure that the work focused on the right subjects. Finally, in section 5 – Method the way to answer to the study’s purpose was defined. In order to ensure the method would be suitable, literature reviews concerning the subject were studied. A more detailed description over how the interviews and the literature reviews were conducted are presented below.

INTERVIEWS

Several interviews were held during the planning phase in order to specify the study and determine its expected results. Interviews with Samuel Grennhag, working as a SCM manager, and Martin Thored, working as a Logistics and Material Manager, were continuously conducted with a semi-structured approach. Interview preparations included directions about topics that were to be discussed, but specific questions were not prepared. According to Stukát (2011) this kind of interview method is suitable when more general information is wanted. The ability to ask follow-up questions entail, according to the author, the opportunity to learn more than first expected because of the interplay between the people participating in the interview. Using a semi-structured approach also gives the informant the opportunity to explain his or hers personal views about a specific topic, which could be of interest in the process of understanding a problem (Denscombe, 2009).

When the study and the expecting results were more specified, continuously interviews with both Samuel Grennhag and Martin Thored were held in purpose to coordinate the study according to what was expected. The interviews were held around once a week with additional spontaneous contact when questions arose. To receive more insight in the daily work, semi-structured interviews have been held with several strategic purchasers. The prepared questions, directed to the unit’s strategic purchasers, are documented in Appendix 2. Furthermore, employees with competence regarding the unit’s inventories, freights and development strategies have been interviewed. General discussions regarding their work assignments were the main subject for these interviews. In Table 3 the interviewed persons,
their job titles and the date when the interviews were held are presented. Continuous contacts have also been held with the unit’s material planners during the planning phase.

Table 3: The persons that have been interviewed during the planning phase in this research.

<table>
<thead>
<tr>
<th>Person</th>
<th>Job title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanna Jungqvist</td>
<td>Inventory specialist</td>
<td>20160215</td>
</tr>
<tr>
<td>Jenny Jonsson</td>
<td>Supplier development engineer</td>
<td>20160216</td>
</tr>
<tr>
<td>Harri Gröhn</td>
<td>Strategic purchaser</td>
<td>20160217</td>
</tr>
<tr>
<td>Torkel Dahlén</td>
<td>Strategic purchaser</td>
<td>20160217</td>
</tr>
<tr>
<td>Helena Bergsman-Smith</td>
<td>Strategic purchaser</td>
<td>20160224</td>
</tr>
<tr>
<td>Jan Bergman Bengtsson</td>
<td>Freight manager</td>
<td>20160224</td>
</tr>
<tr>
<td>Fredrik Stenberg</td>
<td>Strategic purchaser</td>
<td>20160225</td>
</tr>
<tr>
<td>Pär Frinell</td>
<td>Strategic purchaser</td>
<td>20160226</td>
</tr>
</tbody>
</table>

The majority of the planned interviews were held with a tape recorder present, which gave the possibility to listen to the interviews again. Not having to document all facts during the interviews gives the interviewer the opportunity to be more involved in discussions and ask follow-up questions (Bell, 2006). However, transcription of the recording can be very time consuming (Stukát, 2011; Lekvall & Wahlbin, 2001) and to ease the workload, only keywords were documented during the interviews and transcription after the interview only consisted of a description regarding the noted keywords.

The study’s purpose and problem description were also discussed under meetings with both the university’s supervisor Malin Wiger and a pair of students acting as opponents from Linköping University. The meetings were conducted to get other opinions about the study and the direction in which it was going. Another reason was to ensure that the thesis work met the academic requirements set by the university.
LITERATURE REVIEW

The insight gained from the held interviews inspired the literature review which was presented in section 3 – *Theoretical framework*. Articles and books from several authors were used as a foundation for the collected literature review.

In coherence with the search model presented by Bell (2006), the first step in a literature review is a general information search about the subject. After starting with a wide approach the search was narrowed by using more specific words related to the subject. Referenced literatures from more general resources helped narrow the subject even more. Business Source Premier was the primary database for extraction of academic journals, which were used in order to include an academic perspective in the project. Inspired from both Nyberg and Tidström (2012) and Bell (2006) the following five steps compose the used extraction method for the literature reviews.

1. Search for keywords and synonyms in English.
2. Combine keywords with the words OR, AND, NOT for de-escalation and precise the search by checking specific subjects related to the keywords. Also write the number of matches of the research when the keywords successively are added.
3. Choose the references that are articles or academic journals, the ones that have been cited by other authors, peer reviewed and includes more than five pages.
4. First, read the title and subjects to ensure that the articles are relevant for the subject. Continue with the abstract for each document and finally read the article.
5. Save and document the reference, its keywords and the date.

After a general search for journals within the subject, inspirations for relevant keywords were found. Examples of keywords that were used when searching for supplier selection criteria are *strategic, negotiation, purchase* and *vendor selection*. The used keywords and matches from this literature review are presented in Appendix 3, Table 24. In similarity, the literature review regarding consignment stocks includes keywords such as *vendor-managed inventory, consignment* and *consignment policy*. More detailed information about that search are found in Appendix 3, Table 25. Once the keywords were specified, academic journals were selected and relevant theories were documented in the report.

The studied academic journals often consisted of evaluations of previous researches in form of its advantage and disadvantages. Based on the authors’ personal views and experiences they developed the research field by presenting their own conclusions. The academic journals were foremost used as foundation for research concerning supplier evaluation. In order to enable some structure to this report, the authors’ self-chose headings and division of important criteria and sub-criteria were analysed and sorted under the four main heads; cost, quality, service and delivery, which can be seen in chapter 3.3 - *Supplier evaluation*. 

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Another approach to search for literature in this study was to start from a general subject book and track the authors’ referred literatures. This gave an extended insight in the theory and a deeper understanding was obtained. In addition to the subject related literature that are presented in section 3 – *Theoretical framework*, other books were used as a tool for structuring the project and ensure that the chosen project method was suitable. Information regarding interview techniques and data collection tools are examples of used literature that are presented in section 5 – *Method*. Furthermore, the referred literatures in other master thesis have contributed with relevant information in the literature review. Because literatures often consist of secondary data, according to Björklund and Paulsson (2012), and can include the authors’ personal views only general information have been extracted to the study.

### 5.2.2 DATA COLLECTION PHASE

As opposed to the interviews and the literature reviews which were conducted in the initial planning phase, the data collection phase focused on collecting case specific information. The gathered information and data were used to gain an understanding regarding how the four different case representative articles were handled. The current situation could then be defined and cost in form of purchase-, transport- and finally inventory costs could be calculated for respective case. The gathered data could, together with some assumptions and approximations, be used to calculate the alternative scenarios for the four different cases. All collected data and performed calculations were compiled in excel documents which were shared with ABB once the project was finalised. The unit’s access to the underlying data and calculations provided them with an opportunity to continuously update the results from the calculations regarding both the cases’ current situations and their alternative scenario once new data and offers were collected.

Case related data, such as inventory levels, prices and lead time, were extracted from the business system SAP. Costs related to invoices were extracted from another system called SIW. In addition to this quantified data, several interviews were held with both ABB- and University representatives to gain additional information. Personal observations acted as an extra information source and helped understand the current situation at the purchase departments. The collected information from interviews, system data and personal observations, together with the theoretical framework, were used as a foundation for the following analysis phase. More in detail how the data was collected will be presented below.
INTERVIEWS

Similar to the planning phase, several interviews have been held during the data collection phase to receive additional information. A semi-structured approach has been taken on all interviews and a recorder has been used to ensure specific information. In preparation to each interview, several questions were defined. Open discussions were also held to enhance the opportunity to follow up on statements that came up during the interviews.

Based on the information received from interviews and literature reviews in the planning phase, the most important sub-criteria for supplier evaluation could be declared. By combining this information with interviews with the unit’s supervisors Martin Thored and Samuel Grennhag resulted in the mutual decision regarding which specific product groups that the different cases should include. After the kind of products had been determined, the strategic purchasers which were involved with the suppliers that produced the case specific articles were interviewed. In coherence with them, a specific article for respective case could be decided and a further understanding regarding how the collaboration between the unit and the supplier was gained. The interviewed employees are presented in Table 4 and the asked questions in Appendix 4.

Table 4: The interviewed persons during the data collection phase.

<table>
<thead>
<tr>
<th>Person</th>
<th>Job title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harri Gröhn</td>
<td>Strategic purchaser</td>
<td>20160408</td>
</tr>
<tr>
<td>Helena Bergsman-Smith</td>
<td>Strategic purchaser</td>
<td>20160413</td>
</tr>
<tr>
<td>Torkel Dahlén</td>
<td>Strategic purchaser</td>
<td>20160415</td>
</tr>
</tbody>
</table>

Once an article number had been identified the data extractions from the business system SAP and the invoice program SIW could start. Continuous contact with the material planners that ordered the studied articles and employees with competence in transport were also held. Finally, continuous contacts were also held with the supervisors from ABB and Linköping University to make sure that the project stayed on track.
SYSTEM DATA

SAP is the business system that ABB use to structure their business and it stores a range of information. The material planners, at Control Product’s operative purchase department, use the system daily as they place orders, overview the inventory levels or if they need article specific information. (Material planners, 2016) Quantitative data regarding the case articles have therefore mainly been extracted from SAP. The sub-criteria net price, lead time, order quantity, payment terms and inventory levels during the entire year of 2015 were extracted from SAP for each case. The reason why data from the entire year of 2015 was used as foundation for this study was mainly to enable yearly costs to be calculated. By transferring the gathered data to excel documents, calculations and following analyses could be conducted. As mentioned previously, these documents were shared with the unit once the project had been finalised in order to make it possible for them to update the data and see how it would affects the calculated results.

Because of limitations in the purchased applications of SAP, transport related cost could not be extracted directly from the system. Cost related to transport and custom had therefore to manually be found and documented from an invoice program called SIW. A further investigation regarding customs could also be necessary to identify the right cost. By knowing which company that transported the case specific articles and when the goods arrived, the right invoice could be identified. Information regarding both transport and custom charges could then be extracted and manually inserted into excel documents. Because of the lack of authorisation, assistance from the Trade operations manager and the Supplier development engineer at Control Products were provided during these data extractions.

OBSERVATIONS

As an additional tool for data collection, personal observations have been made to further understand the way the daily work at Control Products are conducted. Observing both the operative- and the strategic purchasers’ job assignments separately as well as their collaboration provided extra information. The opportunity to observe the material planners, the supply developers and the Trade operations manager have meant a visualisation over how the employees handle SAP and SIW. Observations have also been obtained during one day in the unit’s production. Observations about the technique behind the products and also what kinds of storages that are currently used were collected. According to Björklund and Paulsson (2012), the usage of observations provides the method with a more relevant and objective insight in the situation.
5.2.3 ANALYSIS PHASE

After collecting all necessary information to answer the research questions, the analysis phase was initiated. The purchase-, transport- and inventory costs have previously been calculated for each case’s respective setups based on both given information and approximations. By combining data and theories, comparisons between the current situation and the alternative scenarios for respective case could be performed in case analyses. The precentral difference between the costs for the current situation and their respective alternative cost were calculated to show which costs that would increase, decrease or be equal to the current situation. A summarisation of the purchase-, transport- and inventory costs showed whether or not a total cost for an alternative setup would be more profitable than the current one.

Even though this study’s main focus has been on the economic effect that different setups would generate, other aspects have been discussed and analysed. In addition to the concrete result that will present which setup would be the most profitable for Control Products to implement, based on purchase-, transport- and inventory costs, the studied theories have also been used in order to determine the suitability of respective setup. Advantages and disadvantages that results from replacing suppliers, the environmental impact and difficulties with implementing a consignment stock are examples on aspects that have been analysed for the different cases and their alternative scenarios.

After each case had been calculated and analysed separately, the gained results and conclusions were compiled in 6.5 - Final analyses. By comparing the different cases, both their current and alternative scenarios could be compared to other where the studied setups and products properties varied. This compilation enabled the study’s purpose to be answered by studying how the purchase-, transport- and inventory costs were affected by different setups. By taken all of these cost posts into consideration, an conclusion on whether or not the total cost would differ in comparison to only include the purchase cost were evaluated. Studied theories have been used to analyse the results from an academic point of view. Furthermore, the collected theories have also been used in order to gain a broader perspective than just viewing the compiled cases from an economical perspective.

Once all the three described phases had been completed, all the defined research questions in chapter 4.4 - Research questions could be answered and the study had then fulfilled its purpose. A more detailed presentation regarding how respective research question has been answered are described on the following page.
5.3 METHODS TO ANSWER RESEARCH QUESTIONS

By answering the defined research questions the study will fulfil its purpose to present guidelines that the strategic purchasers at Control Products can apply when they negotiate with suppliers. A more specific description regarding the method to answer each main question and its subqueries are defined in this chapter.

5.3.1 DEFINING CASES

Entering the data collection phase, the first assignment was to define suitable articles to represent the four different cases. As reasoned in subchapter 4.4.1 - Defining cases, the choice should reflect different situations where the sub-criteria lead time and net price varies. Even though these sub-criteria narrowed the number of possible alternatives there were still plenty of articles to choose from. Discussions were therefore held with both the SCM manager and the Logistics & material manager (2016) during two meetings that lasted in total circa four hours. The discussions were held to choose which kind of product that would be suitable and interesting to analyse further, based on both its properties and its current and alternative setups. It was determined that case one should be a circuit board, case two a thyristor and case three and four should be two different thermosetting resin details. The four specific article numbers were then chosen in coherence with the strategic purchaser that were responsible for negotiating with the suppliers.

5.3.2 PURCHASE COST

The purchase cost for the articles’ current situations was determined by data extraction from SAP and with help from the material planners. The purchase cost was measured by Equation 4 where the net price and yearly ordered quantity during the year of 2015 were used.

Equation 4: The equation to calculate the purchase cost.

\[ \text{Purchase cost} = \text{net price} \times \text{yearly ordered quantity} \]

By transferring the data for net prices and the yearly quantities into excel documents, the costs could be calculated. The followed subquery related to the cases’ current situation could thereafter be answered.

Q1.1: What is the current purchase cost for respective case?

In order to answer the subquery that focused on the cases’ alternative scenarios, different methods had to be used depending on available data. Whether or not the purchase cost would be affected by the studied alternative scenarios was the first thing to determine. If the new setup only impacted the mode of transportation from the supplier the net price was assumed
to be indifferent from the current situation. If however the current situation would change the
costs for the supplier, or if the suppliers were to be exchanged all together, an initial
investigation regarding collected offers were performed. If a new offered net price had been
provided from a supplier it was discussed with the strategic purchasers and the yearly
purchase cost could then be calculated. In cases where there were no concrete offers available,
approximations were done to establish a reasonable net price for the purchased articles. The
approximations were based on the results from the studied cases and were decided in
coherence with the unit’s SCM manager and the Logistics & material manager. In addition, a
sensitivity analysis was performed in order to illustrate how the presented result would differ
based on a varying net price. Finally, in cases were the net price was too uncertain to
approximate, a breakeven method was used. Equation 5 shows how the costs for the current
situation were compared with the costs for an alternative scenario. Equation 6 then illustrates
how the net price was measured when a breakeven method was used.

Equation 5: The equation shows how the costs for the current situation were compared to the costs for the new alternative scenario.

\[
\text{Costs for the current situation} = \text{Purchase cost} + \text{transport} + \text{inventory} = \text{Purchase}_{\text{New}} + \text{transport}_{\text{New}} + \text{inventory}_{\text{New}}
\]

Equation 6: The equation shows how the net price was calculated for the alternative scenarios when a breakeven method was used.

\[
\text{Net price} = \frac{\text{Costs for the current situation} - \text{transport}_{\text{New}}}{r \times \text{ASL}_{\text{New}} + \frac{r \times \bar{Q} \times L \times \text{number of deliveries}}{365} + Q}
\]

\[
r = \text{interest rate}
\]

\[
\text{ASL}_{\text{New}} = \text{average stock level (new)}
\]

\[
\bar{Q} = \text{average order quantity}
\]

\[
L = \text{transportation lead time}
\]

\[
Q = \text{yearly ordered quantity}
\]

For the alternative scenarios where the net price was calculated with a breakeven method, a
profitable setup is consequentially gained if the offered net price would be lower than the
calculated breakeven net price. The subquery that was answered with these methods is:

**Q1.2: What would purchase cost be for the cases’ alternative scenarios?**

By answering the two subqueries, different setups were analysed and calculated in regard to
purchase cost. The main question on how the purchase cost was affected by different setups
could thereafter also be answered. In Appendix 5 there is a presentation of all the subqueries
related to the purchase cost. An illustration over the used methods presented above can be
seen in Figure 14.
5.3.3 TRANSPORT COST

To be able to answer the research questions that focus on transport cost, a variety of methods had to be used. An illustration over the methods to calculate transport cost are presented in Figure 14 and will be further discussed below. Investigations about the current situation in regard to mode of transportation and costs, both interviews and data extraction were necessary. Based on employees’ knowledge and the available information in SAP and SIW, the subqueries could be answered. A more detailed description over who has been interviewed and which programs that data have been extracted from are presented in Table 26, Appendix 5. The transportation invoices were obtained by searching in SIW for the distributors that have transferred the goods from the supplier to Control Products. Received invoices, related to transportations during the year of 2015, from several distributors have been used when calculating the transportation costs for the cases’ current situations. Equation 7 presents how the transport cost was measured from transport invoices. The total invoice cost was not only for the studied article why the weight for all the purchased articles was related to the total weight on the order and multiplied with the total invoice cost. This was then divided by the delivered quantity of the article to get a transport cost per piece. To achieve a total transport cost per year this was then multiplied with the yearly quantity.

Equation 7: The equation shows how the transport cost was measured by invoices.

\[
\text{Transport cost} = \frac{\text{The studied articles weight}}{\text{Total weight on order}} \times \frac{\text{Total invoice cost}}{\text{Delivered quantity of the article}} \times \text{Yearly quantity}
\]

The total invoiced amounts includes all cost that occur as a result of a transport such as sales taxes, fuel, handling and terminal cost. The correlation between the studied articles’ weight and the transportation cost has been used in order to determine how much of the total invoiced amount the articles should stand accountable for. The subqueries related to the current situation were:

- **Q2.1:** Which mode of transportation is currently used for respective case?
- **Q2.2:** What are the current transportation costs for respective case?

Evaluating alternative modes of transportation were based both on transport related theory, presented in subchapter 3.4.1 – Transportation options, and information that were gained from interviews with the unit’s employees. Continuous discussions were held with both the SCM manager and the Logistics & material manager and also with the strategic purchasers whom were responsible for negotiating with the suppliers of the studied articles. Because the alternative scenarios were aimed to be possible to implement within a near future, the chosen alternatives had already been discussed within the unit.
When the alternative scenarios had been decided, calculation regarding their transportation cost could be initiated. All studied alternative scenarios had not yet been investigated by the unit, which meant that no concrete offers had been collected from distributors. Exact cost could therefore not be determined. In order to approximate the transportation cost for the respective scenarios, both invoices related to similar products and a freight calculator have been used as tools. If there were similar products distributed from an alternative supplier and location, the cost for distributing the goods could be determined. By assuming that the correlation between weight and cost would be in the same manner for similar products, the cost for each article could be calculated. The yearly quantity that was ordered during the year of 2015 were collected from the business system SAP and it was multiplied with transport cost per piece in order to determine the yearly transportation cost. This approach was applied for the several different distributors.

For those alternative scenarios that did not have a similar product that matched the alternative setup, ABB’s freight calculator was used to calculate the transportation cost. By inserting input data regarding distributor, mode of transportation, transported route as well as the goods weight, volume and finally the date the goods should have been sent, a transport cost per pallet was generated. The average amount of pallet per delivery and the average deliveries per year were calculated and multiplied with the transport cost achieved from the freight calculator. Equation 8 shows how the yearly transport cost was calculated with the freight calculator.

\[
Transport\ cost = \frac{Cost}{Pallet} \times \frac{Pallets}{Delivery} \times \frac{Deliveries}{Year}
\]

All this information was gained from SAP with the assumption that the goods would be sent with the same frequency as it was in the current situation. As the freight calculator was limited to specific cities and areas, similar distances from a nearby location had to be used. Several distributors were studied with this tool. The subqueries that were answered with the described method are:

**Q2.3:** Which modes of transportation would be plausible for the cases’ alternative scenarios?

**Q2.4:** What would the transportation cost be for the cases’ alternative scenarios?

In order to determine the cost for customs, interviews with the unit’s Trade operations manager (2016) was necessary. Old custom invoices were viewed by using Expeditors (2016) and the total invoiced amount and the insurance percent could therefore be visualised. In order to determine how much of the total cost that should be directed to the specific articles their commodity code had to be identified, which was done with assistance from the Trade
operations manager, in order to receive a duty expression from Tullverket (2016b). Finally, both the net price and the quantity were obtained from the Business system SAP. To calculate the custom cost Equation 9 was used.

**Equation 9: The equation for calculating the custom costs.**

\[
\text{Custom cost} = \left( p \times Q + f \times \left( \frac{p \times Q}{\text{tot invoice amount}} \right) \right) \times (1 + i) \times t
\]

- \( p = \) net price
- \( Q = \) order quantity
- \( i = \) duty expression
- \( f = \) custom freight cost
- \( i = \) insurance percent

By gathering the necessary information and using the equation presented above the custom cost could be determined and the following two subqueries could be answered.

**Q2.5:** What are the current costs of custom for respective case?

**Q2.6:** What would the custom cost be for the cases’ alternative scenarios?

Even though the performed custom calculations in this report always equalled zero, the fact remains that customs are an important part of the transportation cost. Generally, products brought in from outside EU are charged with an extra custom cost why in further calculations for other articles or alternative scenarios the cost should be calculated and added to the total transportation cost.

By answering these six subqueries, different setups were analysed and calculated in regard to transport cost. The main question on how the transport cost was affected by different setups could thereafter also be answered. How all subqueries related to the transport cost have been answered is presented in short in Appendix 5.

### 5.3.4 INVENTORY COSTS

The inventory costs include stock costs and pipeline inventory costs and how the related questions for the current situation were answered will be presented below. The subquery about how much the stock costs were for the respective cases were calculated according to Equation 1, mentioned in subchapter 3.4.2 – Inventory options. Material planners were helpful to bring information from the business system SAP, such as net prices and history about the consumptions and purchasing of the products during year 2015. Because the material planners change the reorder points depending on forecasts and consumption, no safety stocks have been measured for the studied articles. The stock costs for the current situation have therefore been calculated on an average stock level for the articles, based on history during year 2015. Equation 3 presented in subchapter 4.4.4 – Inventory costs measured the pipeline inventory
costs for the current situation. The equation was inspired from Equation 1 and Equation 2 but there are no safety stocks during the transportation and therefore it is not included in the equation. Complemented information as transport lead time was collected from SAP. With the data, an average order quantity, number of deliveries during year 2015 and thereafter a pipeline inventory cost were measured. The two following subqueries could be answered for the four cases after the calculations mentioned above.

**Q3.1:** What are the stock costs for the current situation for respective case?

**Q3.3:** What is the current cost for the pipeline inventory for respective case?

How the subqueries related to alternative scenarios were answered will be presented below. The stock costs were measured in the same way as for the current situation except for the average stock level. For respective alternative scenario, new average stock levels were required and therefore calculated. Many of the alternative scenarios caused longer transport lead times and therefore estimations regarding the expected consumed quantity during these additional days were performed. How many extra days’ consumption that were needed as a result of changed setups were determined in coherence with both the unit’s SCM manager and the Logistics and Material Manager. Based on the updated average stock levels, the stock cost for the alternative scenarios could be calculated. When the stock costs for having a consignment stock were calculated, a week’s consumption was assumed to be extracted each time. This decision was discussed and decided in coherence with the unit’s Logistics and Material Manager. The average stock level that Control Products would be charged for was therefore the half of one week’s consumption. The net price was increased with two percent to cover for the fact that the supplier would stand accountable for distributing products to Control Products.

The costs for pipeline inventory were measured in the same way as for the current situation except for the altered transport lead times which were generated by the changed mode of transportation. In some cases, the transportation lead times for alternative scenarios were compared with other purchase articles that were transported. In other cases, the freight calculator gave the amount of days to transport the goods with a specific mode of transportation. The following questions could thereafter be answered.

**Q3.2:** What would the stock costs be for other alternative scenarios for respective case?

**Q3.4:** What would the cost for the pipeline inventory be for the cases’ alternative scenarios?

By answering these four inventory related subqueries, the main question regarding how the inventory costs will be affected by different setups could be determined. A summarisation on how the subqueries have been answered are found in Appendix 5. An illustration over how the purchase-, transport- and inventory costs have been calculated are also shown in Figure 14.
Profitable negotiations

Figure 14: An illustration over the methods and decisions that have been taken in order to calculate the purchase-, transport- and inventory costs for both the current- and alternative setups.
5.3.5 ANALYSES

All the subqueries presented in the subchapters above were required to answer the main questions and to give an insight in how the current situation and the alternative scenarios would look like for each case. To strengthen and criticise the results, previously research have been used. When the purchase-, transport- and inventory costs were calculated, each of the cost was compared to the respective cost for the current situation in order to view if the alternative scenario would generate cost reducing or increasing. This approach provided a divided insight regarding each cost post. A summarisation of the costs for purchase, transport and inventory were made in purpose to view how the total costs would be for the alternative scenarios compared to the current situation for each case. The correlation between the purchase-, transport- and inventory costs and the summarisation to a total cost could then be visualised for each case by establishing the precentral difference between the current situation's costs and the alternative's costs. By presenting these differences in a concluding table for respective case, the results from performed calculations were clearly visualised. The structure for these tables are shown in Table 5. Even if this gave indications on how the costs would be for specific setups for the alternative scenarios, it still only gave a view for each case in the respective case analyses.

**Table 5: An illustration over how the purchase-, transport- and inventory costs will be compared between the respective cases.**

<table>
<thead>
<tr>
<th>Purchase cost</th>
<th>Transport cost</th>
<th>Inventory costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For respective case</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current situation [SEK]</strong></td>
<td>Current purchase cost</td>
<td>Current transport cost</td>
<td>Current inventory costs</td>
</tr>
<tr>
<td><strong>Alternative scenarios</strong></td>
<td>↓↑ (Precentral difference)</td>
<td>↓↑ (Precentral difference)</td>
<td>↓↑ (Precentral difference)</td>
</tr>
</tbody>
</table>

In order to gain more general aspects, the results from the four cases were compiled and compared with each other in the final analyses. Each of the four tables that had been presented in respective case to visualise the results, by presenting the precentral difference between the current costs for purchase-, transport- and inventories and those that would result from an alternative scenario, were compiled in a final table. Correlations between the specific setups for the alternative scenarios and the costs for purchase, transport and inventory could thereafter be viewed. Conclusions could then be drawn regarding whether or not there would be beneficial for Control Products to include transport and inventory costs when the strategic purchasers negotiating with suppliers. The main question was thereafter answered.

**Q4:** Would Control Products benefit from extending their current focus on purchase cost to also include transport- and inventory costs in future supplier negotiations?
5.4 CREDIBILITY OF THE METHOD

To make believable conclusions in a study, a high level of credibility is important. The three dimensions validity, reliability and objectivity help to make the study more believable. (Björklund & Paulsson, 2012) A presentation over the three dimensions will be shown below.

5.4.1 VALIDITY

Validity is the way a study really measures the right things and having a high validity is important to enhance the credibility of a study (Stukát, 2011). During the time the research were conducted, there have been continuously weekly meetings with the SCM manager respective Logistics & material manager, which are the persons that initiated the project. The meetings were held to ensure that study stayed on track and that relevant aspects were included so the presented results would reflect what was initially asked for. Different kinds of methods such as literature review, interviews, observations and data extractions have been used during the data collection phase. Several methods were used to receive more perspectives on the problem, which Björklund and Paulsson (2012) state makes research more believable. Different perspectives have also been strived after since several persons were involved in the study. Since the project’s start, two student opponents from the university have been involved and critically examined the study’s development. Guidance from the university has contributed with essential information and criticism to increase the validity of the study. Information that was critical for the study have been double checked by contacting the interviewed persons afterwards in purpose to confirm that the right information was collected. Complementary questions though the answers were inadequate were sometimes asked after an interview was held. When contacting and controlling that the right information were collected is an action that Denscombe (2009) mentioned make a higher validity of a research.

5.4.2 RELIABILITY

The way the method gives the same results at iterated analyses is named the reliability (Björklund & Paulsson, 2012). Iterative interviews were held in the research with both material planners, supply developers and strategic purchasers to see if the answers and opinions were the same. Stukát (2011) mentioned that a higher reliability on a research can be received though using the method several times and receiving the same results. When the strategic purchasers were interviewed the same questions were asked except for small changes to fit in to the respective studied article. To use more standardised methods creates a higher reliability according to (Lekvall & Wahlbin, 2001). In this report there are several equations presented and the extracted data was for the year of 2015, which means it is not a changing data. These enable the study to be reproduced easier. Some of the calculations were made by both the
authors at the same time to see if the same answers were achieved. Björklund and Paulsson (2012) stated that the reliability is enhanced when the same results could be reached.

5.4.3 OBJECTIVITY

The final dimension to evaluate is the way the analyses have been influenced by values from the writers (Björklund & Paulsson, 2012). When studied literature has referred to previous research, the original source has always been detected to ensure that the information was correct. Arguments to both strengthen and to criticise the facts were also used to make the analyses more objective. The questions held during the interviews were both made and asked in a way to not guide the questioned in one direction. During the interviews, both the authors of this study were present and after the interviews, discussions concerning the content were held in purpose to see if the collected information was understood the same way. Björklund and Paulsson (2012) stated that the higher the objectivity a study has, the more believable it is.

5.5 CRITICISM OF THE METHOD

Even though measurements have been taken in order to create a study with validity, reliability and objectivity, the study still has its limitations. By bringing forward criticism of the method, the credibility of the results is further discussed.

Conducting a literature review includes extracting information from articles and books that are viewed as important and relevant for the specific study. All authors write their research from a specific perspective that do not necessary corresponds with the one in this study or the ones that they have been compared to. In order to minimise the risk that the authors’ opinions contradicts with the study’s purpose, several different authors have been studied to involve more and varying perspectives. The literature reviews, presented in chapter 3.3 – Supplier evaluation, are an example of where the same area has been studied but the opinions differs.

During the interviews the interviewees were allowed to speak quite freely and therefore their own personal opinions were presented. This method was used in order to get as much information as possible about their area of expertise. In order to gain general information this kind of interviews are considered suitable (Stukát, 2011). If a more structured method had been used, more precisely answers might have been gained. Because the authors of the study were positioned at Control Products, there were opportunities to follow-up on the answers. The information from interviews could therefore be confirmed if there were any questions.

Working close to the unit’s employees meant that the study’s authors were affected by their opinions. As a consequence, this study focuses quite a lot on empirical data and calculations that were requested and valuable for the unit. An example is the cases’ alternatives that were decided based on the unit’s coming supplier development plans. If the study’s authors would
not have been present at the unit during the study, it might have been more focused on academic preferences. In order to ensure that the conducted study still fulfilled the requirements set by the university, continuous meetings with the supervisor from the university were held.
6 CASE PRESENTATIONS AND ANALYSES

The section contains presentations of the four cases that have been studied. Each case were evaluated based on the current situation and alternative scenarios. Purchase-, transport- and inventory costs have been calculated and case analyses sum up every case. Finally, this section ends with more general analyses concerning a common view for the cases and the different setups.

In this chapter, four different cases will be evaluated both in form of the current situation and alternative scenarios. A specific article has been chosen based on its properties to represent each case. Lead time and net price are the two main sub-criteria that have acted as a foundation for the determination of suitable articles. The four different articles are a circuit board, a thyristor and two different thermosetting resin details. The combination of lead time and net price is presented in Table 6, together with the chosen articles.

Table 6: The table shows the combinations of lead time and net price for the chosen articles.

<table>
<thead>
<tr>
<th>Case</th>
<th>Lead time</th>
<th>Net price</th>
<th>Chosen article</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>Long</td>
<td>High</td>
<td>Circuit board</td>
</tr>
<tr>
<td>Case 2</td>
<td>Long</td>
<td>High</td>
<td>Thyristor</td>
</tr>
<tr>
<td>Case 3</td>
<td>Short</td>
<td>High</td>
<td>Thermosetting resin detail</td>
</tr>
<tr>
<td>Case 4</td>
<td>Short</td>
<td>Low</td>
<td>Thermosetting resin detail</td>
</tr>
</tbody>
</table>

The exchange rates are one of the parameters that, in this study, are given a fixed value in order to ease the calculations. An average value over the exchange rate has been used for the whole year of 2015 in order to reflect the year in general. As all results in this study are converted into Swedish currency, articles bought in another one have been converted. As a consequence, one USD equals circa 8.44 SEK and one EUR equals circa 9.36 SEK (Sveriges Riksbank, 2016). Furthermore, all measured costs were rounded according to the range viewed in Appendix 6.

This section will, as has been described, investigate four different cases based on both general and case specific data. One case will be described at a time and each case will contain the subchapters: Current situation, Alternative scenarios and Case analyses. Empirical data and calculations are used to calculate the current purchase-, transport- and inventory costs for respective case. All gained information can be found under the subchapter Current situation. Sensitivity analyses concerning approximated parameters that have been used in order to calculate the current cost will be investigated further. Moving on to the second subchapter, Alternative scenarios, empirical data will again be used to identify and calculate the alternative purchase-, transport- and inventory costs for the presented alternative scenarios. To verify the
result, sensitivity analyses over the assumed and approximated parameters will be presented. Finally, each case chapter ends with the subchapter *Case analyses* where the theories from the theoretical framework are combined with the collected data from both the current situation and alternative scenarios. In *Final analyses* the analyses for each case is combined with each other into one common analyse. The structure of this section is illustrated in Figure 15.

![Empirical data]

**Figure 15**: An illustration over this section’s structure. Each case will include investigations concerning the current situation, alternative scenarios, case analyses and it will end with final analyses.
6.1 CASE 1

Case one is based on long lead time and high net price, see Table 6 above. A specific circuit board was decided to be suitable to represent case one. The possibility to change the mode of transportation from airplanes to boats has been discussed as a way to reduce costs. Other discussed alternatives for this circuit board included creating a dual-source solution or transfer all the purchase quantity to another supplier. Because the case would provide information regarding the impact these changes would have on the unit’s costs, it was determined to be a suitable article. (Strategic purchasers, 2016)

6.1.1 CURRENT SITUATION

The circuit board is purchased from Circuit board supplier-A. The facility for the circuit board assembly is situated nearby the sea in south-east of China in the town Shenzhen. The current setup can be described as the supplier purchase components from their suppliers to enable assembly of circuit boards. Once an order is placed by Control Products the assembly of the ordered quantity starts. Distribution to Sweden is done by air transportation and trucks are used for the final distance. Once arrived, the articles are placed in inventory until they are assembled into contactors. (Strategic purchasers, 2016)

In order to calculate the current costs for purchase, transports and inventories, case specific data have been collected. Apart from the data presented in Table 7, the consumption and demand have been collected and used for further calculations.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly quantity</td>
<td>65 938</td>
<td>PC/year</td>
</tr>
<tr>
<td>Article weight</td>
<td>0.105</td>
<td>Kg</td>
</tr>
<tr>
<td>Duty expression</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>Transportation lead time</td>
<td>5 Days</td>
<td></td>
</tr>
<tr>
<td>Number of deliveries</td>
<td>45</td>
<td>Deliveries/year</td>
</tr>
<tr>
<td>Average delivered quantity</td>
<td>1 465</td>
<td>PC</td>
</tr>
<tr>
<td>Net price</td>
<td>8.91</td>
<td>USD</td>
</tr>
<tr>
<td>Average stock level</td>
<td>8 866</td>
<td>PC</td>
</tr>
</tbody>
</table>

The purchase cost for the current situation was measured to circa 5 000 000 SEK per year. A description over more detailed information regarding transports and inventories under respective heading below, starting with an investigation about the current transport cost.
TRANSPORT COST

Because the circuit boards are purchased from a supplier located in China, the transported distance is far. Trucks are used to transfer the goods from the supplier’s production site to the nearest airport. Air transportation is then applied to deliver the articles all the way to Arlanda in Sweden. A specific distributor transports the goods with airplanes. Once at Arlanda, another transhipment to trucks are conducted to transport the circuit boards the last distance to Control Products. (Strategic purchasers, 2016)

The lead time consists of both the time it takes for the supplier to produce and finalise an order and the time it takes to transport the goods all the way to the unit’s premises. The supplier’s production lead time has been negotiated to not exceed 30 days and the transportation lead time is set to five days. An illustration over the circuit boards’ way from the supplier to the unit’s production site is presented in Figure 16.

![Figure 16: An illustration over the circuit board’s way from the supplier to the unit’s production site. The lead time amounts to 35 days.](image)

The cost related to the distribution of circuit boards are divided into transportation- and custom costs. There are two different distributors that transfer the circuit boards from the supplier’s factory to the production facility in Västerås. Two different distributors are used to transport the goods to the unit. As a result of this setup two different invoices are sent to Control Products, one from each distributor for each delivery. To transport one article by air transportation, an average cost of circa six SEK per circuit board was calculated. In similarity, the average cost for the truck transport was amounted to circa 0.1 SEK per circuit board. It resulted in 400 000 SEK/year for air transportation and circa 6 000 SEK/year for truck transportation. Looking from a year perspective, the total sum for transportation of the studied article during 2015 was circa 406 000 SEK.

When the goods arrive to Arlanda Airport they have to pass through the custom control. Based on the circuit boards properties they are defined with the specific commodity code: 8542 39 10 00. Articles defined by this commodity code have the duty expression zero percent when taken through customs (Tullverket, 2016b). Consequently, there is no addition custom cost for importing circuit boards from suppliers located outside EU’s boarders.
INVENTORY COSTS

The current inventory management consists of collaboration between the unit and Circuit board supplier-A. As the unit plan their coming production based on received and anticipated customer orders, they send prognoses to Circuit board supplier-A to enable them to better plan their production. To further support and ease the suppliers ordering process, the provided prognoses act as an approximately order that the unit takes responsibility for and buys, even though the unit’s demand has not been as large as expected. For the set prognosis for three months ahead only small changes in the ordered quantity are acceptable. This setup gives the supplier a chance to order components in time to make sure that they can manage the production once an actual order is placed. The ordered components are placed in an inventory at the supplier’s factory and are only assembled into circuit boards once an actual order is placed. Once the distribution starts and the pipeline inventory is created, costs for inventories arise at Control Products. (Strategic purchasers, 2016)

During the time the circuit boards are transferred from China to Västerås they tie up capital that cannot be used in any other ways. The conducted calculations shows that during an average day of the year, an amount of circa 6 000 SEK are tied to pipeline inventories. This cost only reflects the cost of having the circuit boards placed on airplanes and trucks. Once they arrive to Control Products they are placed in the unit’s own stock in anticipation of being assembled with other components into a contactor.

To calculate the cost of having the circuit boards in inventory at Control Products, an evaluation over how the stock level has changed during the year of 2015 was compiled. All inventory extractions and refills have been studied to determine the stock level over time. Figure 17 below illustrates both the varying stock level and the average stock level on 8 866 pieces. The calculations showed that the stock cost was circa 60 000 SEK in average during the year 2015. The total inventory costs for the current situation are summarised to circa 66 000 SEK.

Figure 17: An illustration over the circuit board’s inventory level during the year of 2015. The average stock level is also displayed.
SENSITIVITY ANALYSIS

After the yearly purchase cost, the transportation cost for the current situation is the most costly for the unit. As this cost post consists of parameters that in some degree have been estimated, a sensitivity analysis has been performed. Furthermore, the result from the conducted calculations shows the air transportation cost holds the majority of the total transportation cost why it has been placed in focus. The transportation cost has been compiled from a selection of actual invoices, which means that all invoices during the year of 2015 have not been taken into account. Furthermore, all invoices include more articles then the case studied circuit board, why the total invoiced amount has been divided to the different items. These two aspects affect the average transportation cost per circuit board, why it might not be completely accurate and should therefore be further evaluated. In Figure 18 below the air transportation cost’s variation is shown depending on how the cost per circuit board varies. The figure visualises the difference between the minimum, the average which was the one that has been used and the maximum values that were detected from studied invoices.

![Sensitivity analysis over the air transport cost](image)

Figure 18: An illustration over how the transport cost per circuit board affects the total air transport cost.

As illustrated by the conducted sensitivity analysis, the total air transportation cost varies quite a lot depending on the chosen value of cost per circuit board. Comparing the maximum value with the minimum, there are an amount of circa 121 000 SEK per year that differs. A conclusion can therefore be drawn that the transportation cost presented in this report can vary in a range of ± 60 000 SEK. However, looking over a longer time period the average value should be accurate enough.
6.1.2 ALTERNATIVE SCENARIOS

After discussions with the SCM manager (2016), two alternatives to the current transportation were interesting to investigate. These two were chosen because of the relevance the results gave for future work for Control Products. The two alternatives that were investigated are to use boat transportation from the supplier to Västerås and the other one was to buy the circuit boards from Poland and transport the goods with trucks to Sweden. For both the alternative scenarios, the purchased quantity and the order frequency are assumed to be similar to the current situation. A further presentation of the respective alternatives will be described below.

BOAT TRANSPORTATION

Because air transportation has been shown to be expensive, an alternative scenario with sea transportation is relevant to study further. Trucks from Circuit board supplier-A’s facility to a harbour located in Shenzhen in China would in that case transport the goods. After transhipment, the distributor would transport the circuit boards all the way to the harbour in Göteborg. To transport the goods the final distance to Control Products facility, trucks would be used. The alternative scenario are visualised in Figure 19 and all assumptions that have been made to calculate the costs concerning the boat transportation are presented in Appendix 7, Table 28.

![Diagram of boat transportation](image)

**Figure 19:** Illustration over the alternative way from the supplier’s production to the unit’s production site. The lead time amounts to 78 days.

Given the assumption that the supplier’s production lead time would not be affected by the alteration to sea transportation, it would still amount to 30 days. Because there are currently no existing boat transports from China the transportation lead time for the sea transportation has to be estimated. The unit currently ship products from Thailand to Göteborg, which in general takes about 46 days. Because of the relative close distance between the countries, the transportation lead times are estimated to be similar. Apart from the sea transportation, the goods also have to be transferred to the harbour in China and from the harbour in Göteborg to Västerås. Two extra days are therefore added for truck transportation. The lead time are therefore assumed to be 78 days.
Profitable negotiations

The net price was assumed to be the same as the current situation as it is only the mode of transportation that is affected by this alternative scenario. The purchase cost would therefore be the same on circa 5 000 000 SEK. Calculation of the transportation cost has been done by applying the freight calculator and summarising the cost for the three transport distances. The results from the calculations indicate a yearly transportation cost of 40 000 SEK for distribution from the supplier to the harbour in China, 59 000 SEK with the boat transportation and 35 000 SEK to transport from Göteborg to Västerås. The total costs added up to circa 134 000 SEK, which is together with the transportation lead time visualised in Table 8.

Table 8: A presentation of the transportation costs and lead time during the transportation from Shenzhen in China to Västerås.

<table>
<thead>
<tr>
<th>Transportation</th>
<th>Transportation lead time [days]</th>
<th>Transport cost [SEK/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck from supplier to the harbour in China</td>
<td>1</td>
<td>40 000</td>
</tr>
<tr>
<td>Boat from harbour in China to Göteborg</td>
<td>46</td>
<td>59 000</td>
</tr>
<tr>
<td>Truck from Göteborg to Västerås</td>
<td>1</td>
<td>35 000</td>
</tr>
<tr>
<td>Transportation in total</td>
<td>48</td>
<td>134 000</td>
</tr>
</tbody>
</table>

In regard to stock, some differences would be generated as a result of changing the mode of transportation. Because the transportation lead time would increase with 43 days, from five days with air transportation to 48 days with sea transportation, an increased stock level is needed to cover for the extra uncertainty. Four weeks consumption of the studied circuit board is requested (Logistics & material manager, 2016). The average stock level during the year of 2015 would then be raised to 15 000 pieces, which would generate a stock cost of 100 000 SEK. The increased transportation lead time would also generate an increased pipeline inventory cost. Conducted calculations show a pipeline inventory cost of 59 000 SEK, which added with the stock cost means that the total inventory cost would be 159 000 SEK. The economic affect the alternative scenario would bring to inventory costs is presented in Table 9.

Table 9: A presentation of the inventory costs for the alternative with boat transportation.

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Cost [SEK]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock costs</td>
<td>100 000</td>
</tr>
<tr>
<td>Pipeline inventory costs</td>
<td>59 000</td>
</tr>
<tr>
<td>Total inventory costs</td>
<td>159 000</td>
</tr>
</tbody>
</table>
The alternative scenario with a replacement of the current air transportation with sea transportation would, according to performed calculations, generate a yearly transportation cost of circa 134,000 SEK and the inventory cost would on an average day amount to 159,000 SEK. The purchase cost would be the same as the current situation on 5,000,000 SEK per year. Another alternative scenario to lower the transportation cost would be to move the production to another supplier and this will be analysed in the following alternative scenario.

PURCHASE FROM POLAND

Control Products purchase the circuit boards which are used as a component in the unit’s softstartes from Circuit board supplier-B, situated in Poland. A plausible option would therefore be to extend the consisting relationship with the supplier by allowing them to produce the circuit boards that are used in contactors as well. To enable a comparison between the current situation and this alternative scenario, calculations regarding the purchase-, transport- and inventory costs have been performed for the studied circuit board under the assumption that it would be bought from Circuit board supplier-B instead of Circuit board supplier-A.

The used mode of transportation for the circuit boards purchased from Circuit board supplier-B is trucks (Material planners, 2016). Based on the assumption that the same distributor would be used for the additional circuit boards a transportation cost could be calculated. Based on the freight calculator the transportation cost would be circa 189,000 SEK per year. However, as the town in which the supplier is situated do not appear as a possible option in the freight calculator the city Czerwonak, located 480 kilometers away, has been chosen as a starting point for the transport. From this city to Västerås the freight calculator generates a yearly transport cost of circa 140,000 SEK. Based on the cost per kilometer the additional distance could be included for an extra charge of circa 49,000 SEK per year.

To verify the reliability of these calculations, transport invoices regarding the softstarter’s circuit boards way from Circuit board supplier-B to Västerås have been studied. Because there are no current circuit boards that are bought from Poland with the same weight and measurements as the case specific article, some assumptions were made to calculate the cost. Two circuit boards were used to extract relevant data. Their weights create a range in which the studied circuit board for the contactor is included. By calculating the yearly transport cost for each of the two softstarters’ circuit boards and use a gradient between them, an approximate cost for a circuit board with the weight of 0.105 kilograms was decided. As a result, the transportation cost based on invoices shows a yearly cost of circa 75,000 SEK. The results from performed transport calculations are presented in Table 10 and all assumptions are described in Appendix 7.
Table 10: Presentation over the alternative yearly transportation cost from Circuit board supplier-B to Västerås.

<table>
<thead>
<tr>
<th>From Circuit board supplier-B to Czerwonak</th>
<th>Freight calculator [SEK/year]</th>
<th>Invoices [SEK/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>49 000</td>
<td></td>
</tr>
<tr>
<td>From Czerwonak to Västerås</td>
<td>140 000</td>
<td></td>
</tr>
<tr>
<td>Total transportation cost</td>
<td>189 000</td>
<td>75 000</td>
</tr>
</tbody>
</table>

Based on initiated negotiation, the net price would be maximum 8.23 EUR per piece (Strategic purchasers, 2016), which would correspond to a yearly purchase cost of circa 5 100 000 SEK. This would be an increment with circa 100 000 SEK per year compared to the current situation. Because the alternative supplier is located much closer than the one currently used, the risks related to transportation lead time is reduced. As a result, the inventory level can be lowered with at least two days consumption according to the Logistics & material manager (2016). Based on these two alternatives in the data foundation the cost for both pipeline inventory and the unit’s stock cost can be calculated. The transportation lead time is seven days which generates a pipeline inventory cost of circa 7 500 SEK. The conducted calculations also show a stock cost that amounts to circa 59 000 SEK. As a result the total cost for inventories by changing from Circuit board supplier-A to Circuit board supplier-B is circa 66 500 SEK. The results from the calculations are presented in Table 11 below.

Table 11: A presentation of the alternative inventory costs when purchasing from Poland.

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Cost [SEK]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock cost</td>
<td>59 000</td>
</tr>
<tr>
<td>Pipeline inventory costs</td>
<td>7 500</td>
</tr>
<tr>
<td>Total inventory costs</td>
<td>66 500</td>
</tr>
</tbody>
</table>

If Control Products would buy their circuit boards for the contactors from Poland instead of China, the yearly transportation cost would be somewhere between 189 000 SEK and 75 000 SEK. Furthermore, the total inventory cost would be circa 66 500 SEK and the purchase cost would be 5 100 000 SEK per year. The robustness in the presented alternative costs will be further investigated in the following sensitivity analyses.
SENSITIVITY ANALYSES

Several of the input data that were used in the conducted calculations are approximated based on available information. The alternative scenario with sea transportation was based on a transport lead time of 46 days from port to port and two addition days for truck transport. The decision to use this value affects both the pipeline inventory stock and the stock level at the unit. If the transportation lead time would increase or be reduced with seven days, the inventory costs would vary. Given the assumption that the average stock level would increase/decrease with one week’s consumption the result would be a cost difference of circa 20 000 SEK in either direction. In Figure 20 below the result is visualised.

With the second alternative scenario, changing to a supplier located in Poland, the net price is an uncertain parameter. In initiated negotiations, the offered net price is 8.23 EUR per circuit board, which has been used when calculating the alternative scenario. However, the negotiations are not yet finalised and the net price is expected to be reduced down to slightly below 8.00 EUR per piece. This corresponds to a reduction of circa three percent and it is seen as a plausible outcome after further negotiations. (Strategic purchasers, 2016) To investigate how big impact the net price has on both the yearly purchase-, transport and inventory costs a sensitivity analysis has been performed for this parameter as well. The result is presented in Figure 21 below.
Profitable negotiations

The result of the sensitivity analysis shows a distinctive correlation between net price and total purchase cost, which is not surprising. Based on the given offer with a net price of 8.23 EUR per piece the total purchase cost will increase with circa 100 000 SEK per year for the alternative scenario compared with the current situation. Furthermore, the stock cost will slightly increase as a result of the higher price and the pipeline inventory cost will decrease with a small marginal. If however a better deal can be negotiated with Circuit board supplier-B that reduce the net price with over two percent, a saving in regard to the total purchase cost can be obtained. The same relation can be detected in regard to inventory costs, however the differences are only a couple hundred SEK.

After studying and calculating costs for both the current situation and alternative scenarios, several conclusions can be drawn. The following subchapter therefore consists of several analyses concerning case one.

### 6.1.3 CASE ANALYSES

In this case, the current situation was compared with an alternative mode of transportation and an alternative supplier. By switching from air- to sea transportation the transport cost would be distinctly reduced. However, in order to handle the increased transportation lead time, the stock level would have to be raised and consequently the total inventory cost would increase. The second alternative scenario consisted of a replacement of the current supplier by extending the collaboration with Circuit board supplier-B situated in Poland. The result from this change showed reduced transport- and inventory costs as a result of the closer distance between the supplier and Control Product’s facility. Because the transportation cost has been calculated both with the freight calculator and by studying invoices, the actual cost is probably

### Sensitivity analysis over the net price's impact on the yearly purchase-, transport- and inventory costs

*Note that the yearly purchase cost is so much higher than the other cost why the figure do not start from zero.

Figure 21: An illustration over the net price's impact on the yearly purchase-, transport- and inventory costs.
somewhere in between these two numbers. The transportation cost is therefore assumed to be the average values of the two results which means circa 130 000 SEK per year. The offered net price from Circuit board supplier-B would also generate an increased yearly purchase cost that differs with circa 100 000 SEK per year in comparison to the current situation. In Figure 22 the current situation is compared with the two alternative scenarios from an economical perspective.

By only studying the transport- and the inventory costs, the result from the performed calculations indicated that switching vendors and start using Circuit board supplier-B in Poland instead of Circuit board supplier-A in China would be the most profitable alternative. A total transport- and inventory cost reduction of circa 58 percent would be gained by choosing Circuit board supplier-B in comparison to the boat alternative that would generate a reduction of circa 38 percent. However, even though the transport- and inventory costs reduce in comparison to the current situation, the net price would increase and as a consequence so would the total purchase cost if Control Products would start purchasing from Poland. Adding this aspect to the calculations, the economic difference between the boat alternative and the Poland alternative only differs with circa 24 000 marginal, in benefit for the boat alternative. The yearly purchase-, transport- and inventory costs would reduce with circa 3.3 percent if the goods were shipped by boat and circa 2.8 percent if Circuit board supplier-B would be used.

The globalisation trend has made it essential for companies to enlarge their purchase market and start buying from the supplier that can offer the best price (Baily, 1997; Chen & Yang, 2003). As a consequence, suppliers with their production located in developing countries have been an attractive choice because of the cheap net prices they can offer as a result of low labour costs (Van Weele, 2012). From a theoretical perspective, the net price is valued as one of the
Profitable negotiations

- top priorities when choosing a suitable vendor (Weber et al., 1991; Baily, 1997; Chen & Yang, 2003; Monczka et al., 2005; Narasimhan et al., 2006; Şen et al., 2008; Lee & Drake, 2010; Kahji & Shafaei, 2011; Wu & Weng, 2010; Ravindran et al., 2010). Traditionally, Control Products has offshored a lot of manually demanding products to Asia in order to receive lower net prices. However, the strategic purchasers have observed a trend when China is a country under development, which continuously grows stronger and is therefore more expensive to purchase from. The trend results in increasing net prices in Asia why they want to purchase more from Europe instead. The studied circuit board has been offered for a net price of 8.23 EUR per piece in initiated negotiations with Circuit board supplier-B. (Strategic purchasers, 2016) This initial offer would be more expensive than the one currently offered by Circuit board supplier-A in China. If however the net price could be reduced with only one percent, changing to Circuit board supplier-B would generate more cost savings than changing mode of transportation. As the net price is anticipated to reduce further (Strategic purchasers, 2016), changing the supplier of circuit boards would properly be the most economical profitable alternative.

One of the aspects that differ regarding which alternative that is chosen is the transportation lead time. The current situation with air transportation compared to the alternative scenario with purchasing from Poland is quite similar from a time perspective. Changing the mode of transportation by start shipping the goods from China, would in comparison take much longer time. Establishing reliable and fast deliveries are one of the most important aspects which should be negotiate about with suppliers (Weber et al., 1991). In addition, the received goods have to include all ordered and expected products to be useful for the costumer (Mei-Ying & Yung-Chien, 2010). At Control Products, the strategic purchasers negotiate with their suppliers about the lead time with the aim to reduce it as much as possible. However, the focus in these negotiations is the supplier’s production lead time and not the transportation lead time. As a consequence, the transportation lead time is currently not that prioritised by the strategic purchasers. (Strategic purchasers, 2016) The fact the mode of transportation and transportation lead time are not discussed, the most profitable choice is not necessary chosen. Even if the circuit boards were to be transferred to Sweden by boat and the unit’s stock levels were adjusted to cover the extra uncertainty, it would still be distinctly more cost optimal than using airplanes. The transportation cost would be reduced with circa 67 percent, which means a yearly cost saving of circa 270 000 SEK, simply by switching from airplanes to boats.

Based on the fact that during the last six months of the year 2015 the consumption was not at all as high as expected, the inventory levels grew high. Because circuit boards are quite expensive the cost of having inventories grew high. As illustrated in Figure 17 above the increased inventory level created a situation that is not wanted. Because of the setup with Circuit board supplier-A, to buy similar quantities as the prognosis for the nearest three months implied, the stock kept increasing even though the demand was sinking. When the level was at its highest, circa 26 000 circuit boards worth almost 2 000 000 SEK were stored at
Control Products inventory. This inventory alone would be enough to cover more than 13 average weeks’ consumption of circuit boards. According to Baily (1997) higher inventory levels are necessary when the lead time is long in order to create some safety if something unexpected was to happen. Finding a suitable level for the safety stock is however not prioritized at the unit today. Instead orders are placed based on a reordering point that is set and changed manually based on given information and experience (Material planners, 2016). In order to ensure that the same stock increase, as during the last six months of 2015, not occurs again more accurate prognoses are necessary. By providing the supplier with more correct prognoses the placed orders do not have to be as different from what is wanted. Another alternative is to decrease the time the unit is required to purchase in coherence with the prognoses. However, this creates difficulties for the supplier who will have a harder time to plan their production and order components in time.

Based on the current situation, with purchase from China, and the alternative boat- and supplier exchange alternatives, the purchase-, transport- and inventory costs have been calculated. Worth mentioning is the other factors that would impact the suitability of the different options. From an environmental perspective, the high usage of air transportation has a big negative impact on the environment. In comparison to this, both boat transportation and truck transportation would be preferable. (Pewe, 2002) Another affecting aspect is the wanted flexibility, which varies depending on the supplier’s location and the used mode of transportation (Nilsson, 2000). Because Circuit board supplier-B is situated much closer to the unit than Circuit board supplier-A creates extra flexibility. Flexible and fast deliveries can be offered by using truck transportation are the main reasons why it is such an attractive mode of transportation (Pewe, 2002). The fact the circuit boards are expensive and need to be handled with some caution gives, according to Coyle et al. (2013), indications that truck transportation would be suitable. Even though these aspects have not been converted into costs, they would still affect the total cost why a further investigation regarding these aspects is recommended.

This case has proven that by taking purchase-, transport- and inventory costs into account when negotiation with suppliers, costs can be distinctly reduced. How the different cost post varies in comparison to the current situation are visualised in Table 12. Both switching mode of transportation to boats and exchanging the supplier to Circuit board supplier-B would reduce Control Product’s purchase-, transport- and inventory costs with circa three percent.

Table 12: Presentation of the results from case one, where the current situation is compared with two alternative scenarios.

<table>
<thead>
<tr>
<th></th>
<th>Purchase cost</th>
<th>Transportation cost</th>
<th>Inventory costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current situation [SEK]</strong></td>
<td>5 000 000</td>
<td>406 000</td>
<td>66 000</td>
<td>5 476 000</td>
</tr>
<tr>
<td><strong>Boat alternative</strong></td>
<td>Equal</td>
<td>↓ (67%)</td>
<td>↑ (139%)</td>
<td>↓ (3%)</td>
</tr>
<tr>
<td><strong>Poland alternative</strong></td>
<td>↑ (2%)</td>
<td>↓ (68%)</td>
<td>↓ (0%)</td>
<td>↓ (3%)</td>
</tr>
</tbody>
</table>
6.2 CASE 2

Because of a large interest in products with long lead times and high net prices, this second case will also reflect an article with these properties. The chosen article for case two is a specific thyristor, which is used as a component in one of the unit’s produced softstarter. The reason why this article has been chosen as a suitable case representative is the speculations regarding the possibility to enforce a consignment stock solution. (Strategic purchasers, 2016)

6.2.1 CURRENT SITUATION

The thyristor is bought from Thyristor supplier-A, which is one of ABB’s key suppliers. The main production of thyristors is located in Slovakia but there is also a stock in Germany where the goods that are purchased from Sweden are distributed from. Once an order is places by the material planners at Control Products it takes 28 days until the goods are ready for distribution. After that the thyristors are placed on trucks that transfers them to the unit in Västerås. Once arrived, the articles are placed in the unit’s stock until they are assembled into softstaters. (Strategic purchasers, 2016) Performed calculations showed purchase costs for thyristors on 4 500 000 SEK during the year of 2015.

The data foundation that has been used in order to calculate the current cost is presented in Table 13. In addition to the presented data, more detailed information regarding consumption and demand have been collected to enable calculations. Why this case has not performed any calculation regarding transportation will be described below followed by a presentation regarding the current inventory costs.

Table 13: Presentation over data regarding the thyristor studied in case two.

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly quantity</td>
<td>8 064 PC/year</td>
</tr>
<tr>
<td>Article weight</td>
<td>1.34 Kg</td>
</tr>
<tr>
<td>Duty expression</td>
<td>0 %</td>
</tr>
<tr>
<td>Transportation lead time</td>
<td>2 Days</td>
</tr>
<tr>
<td>Average delivered quantity</td>
<td>323 PC</td>
</tr>
<tr>
<td>Net price</td>
<td>59.10 EUR</td>
</tr>
<tr>
<td>Average stock level</td>
<td>1 214 PC</td>
</tr>
</tbody>
</table>
TRANSPORT COST

The production lead time is 28 days from ordering until the goods can be delivered. The goods directly from the inventory in Germany to Control Product in Västerås. The transportation lead time is two days and the cost is supposed to be charged to the unit in coherence to the negotiated FCA agreement. The cost is however currently charged to the supplier, which means that no transport invoices were received during the year of 2015. The yearly transportation cost is therefore equalled to zero SEK. (Strategic purchasers, 2016)

Even though the cost for transportation of thyristors from Thyristor supplier-A during the entire year of 2015 equalled zero SEK, no additional cost on the net price has been identified. The reason is probably that either Thyristor supplier-A or Control Products have identified this mistake and no action has therefore been taken to correct the situation. (SCM manager, 2016)

INVENTORY COSTS

As a result of the mistake regarding transportation invoices, the pipeline inventory cost also equalled zero SEK during the year of 2015 as Control Products only has been accountable for the goods once it arrives at their own facility.

Calculations showed the average stock level during the year of 2015 was 1214 thyristors. In Figure 23 the varying inventory level is shown in relation to the average stock level. Results from calculations showed the stock cost for the current situation is circa 60 000 SEK.

Because the stock cost is the only one that has generated costs, apart from the purchase cost, there is no need to perform any sensitivity analyses as all input data is accurate and nothing in these calculations have been approximated. An investigation regarding the consequences of implementing an alternative consignment stock solution is therefore the next step.

Figure 23: Illustration over the specific thyristor's varying stock level during the year of 2015.
6.2.2 ALTERNATIVE SCENARIO

As a measure to reduce inventory levels throughout the entire organisation, introducing a consignment stock solution for suitable articles has been discussed. One of the articles that was mentioned as suitable is the specific thyristor that is studied in this case. (SCM manager respective Logistics & material manager, 2016) The alternative scenario that was evaluated in this study consists of a change from a reordering system to implement a consignment stock for the thyristor.

IMPLEMENTING A CONSIGNMENT STOCK

Implementation of a consignment stock would mean Thyristor supplier-A would stand responsible for refilling the stock located at Control Products. Consequently, the transportation agreement would change so the supplier arranges and pays for the transportation and adds an extra charge on the net price instead. Even when the goods have arrived and been placed in the unit’s inventory, the supplier stands accountable for the stock cost. Control Products only pay for the thyristors once they have been extracted from the inventory in order to be assembled in softstarters. All assumptions which were used in the performed calculations are presented in Appendix 7.

To ease the invoice handling and get a good flow in the production, several thyristors would be extracted from the consignment stock each time. Given the assumption that one week’s average consumption, rounded up to include a whole box, the weekly extracted quantity would be 174 thyristors. Furthermore, an additional assumption regarding the changed transportation agreement’s affect would have on the net price had to be done. Based on calculation from the other cases, the transport cost for deliveries from Europe have been in the range of 1.6-4.0 percent of the total purchased cost. According to the SCM manager (2016), a good approximation would be to add two percent to the net price. An extra charge of eleven SEK is therefore added on the net price to cover transportation, which corresponds to a yearly purchase cost of circa 4 500 000 SEK which would be an increment compared to the current situation. Given that the stock Control Products would stand accountable would consists of the average value of the extracted weekly quantity and that the thyristors’ net price would increase with two percent, the unit’s stock cost would be circa 4 500 SEK.
SENSITIVITY ANALYSIS

There are two parameters that have been approximated in the conducted calculations, performed for this case. The quantity of the extracted thyristors has been assumed to cover one week’s consumption and the added transportation cost has been approximated to two percent of the total purchase amount. Because of the net price’s big impact on the yearly cost, only this parameter will be investigated further in a sensitivity analysis.

In regard to the net price’s impact on the stock cost an addition sum of circa eleven SEK, which corresponds to a two percent increase, has been used when the alternative scenario has been calculated. The added transportation cost could be higher than expected and it is furthermore possible that Thyristor supplier-A would demand compensation for the additional service that comes with a consignment stock. However according to the sensitivity analysis, visualised in Figure 24, the added two percent would in itself be too much and the yearly purchase- and stock cost would increase compared to the current situation. The results shows the net price can only be allowed to increase with 1.2 percent in order to keep the consignment stock solution profitable. However, this result is based on the current situation were zero SEK was paid for transportation during the year of 2015. If the invoices were sent as they were supposed to, the cost for the current situation would increase and as a consequence a higher net price could be accepted for the consignment stock solution to be profitable.

Figure 24: An illustration over the correlation between the thyristor’s net price and the yearly purchase- and stock cost for the unit.
*Note the cost for the current situation do not include any transportation costs as it was measured to zero SEK during the year of 2015.
**Note the purchase cost is distinctly larger than the stock cost why the figure do not start displaying cost from zero SEK.
6.2.3 CASE ANALYSES

In this case the effect of switching from a reordering system to a consignment stock is investigated based on the purchase- and the stock cost. The parameters that would change as a consequence of this implementation are the net price and the average inventory level. As the supplier would stand accountable for the transportation, a compensation for this cost would be added to the net price. Furthermore, the average stock level would be reduce distinctly as a result of that the supplier would be responsible for the inventory as long as it is not extracted by Control Products’ production. The result would be a cost reduction of 93 percent if only stock cost was taken into account. However, according the sensitivity analysis, visualised in Figure 24, the big impact on the stock cost in the alternative scenario do not cover for the increased purchase cost that results from an increased net price. In order for a consignment stock solution to be more profitable than the current situation, the net price can only increase with 1.2 percent. Important to note are that Control Products do not pay any transportation cost in the current situation even though they should. If this cost were paid as it was supposed to, the net price could increase even more and a consignment stock would still be profitable.

Seen from a theoretical perspective, there are many positive aspects that would be generated by implementing a consignment stock solution. By not letting the buyer stand accountable for the ordering of new material, the risk for over- and understocking inventory levels would be reduced (Zanoni et al., 2014; Battini et al., 2010a). Even though the inventory management tend to lower the inventory levels, the availability is often increased (Zanoni et al., 2014). As the material planners at Control Products currently face high demands to never get shortage of material, the inventory levels tend to be higher than necessary (Material planners, 2016). The result from the performed stock level variations during the year of 2015, showed that the stock level was only under 500 pieces three times during the entire year. Furthermore, the lowest value was 473 pieces in stock, which correspond to almost three weeks consumption of thyristors. As each thyristor is quite expensive, having a large stock is costly for the company.

Another positive aspect with consignment stocks are the reduced management costs as a consequence of extending the collaboration with the supplier and implement a solution where the inventory level variations are available for the supplier to study (Battini et al., 2010a). This requires compatible systems in form of either EDI or on-line data update (Battini et al., 2010b). At the unit, these kinds of solutions are not fully developed yet why their current consignment stock demand a lot of manual assignments in order to work properly (Material planners, 2016). Enforcing additional consignment stocks would therefore require even more manual work, which is costly and time consuming. As the cost investigation in this study does not include cost for manual work, the actual cost could be much higher than represented by the stock cost alone. A further investigation over the impact manual work would have on the costs are
therefore called for and further development to ease the handling would properly be necessary before implementing another consignment stock at the unit.

The suitability to enforce a consignment stock is according to Corbett (2001) depending on the vendor’s production cycle. A long production cycle is according to the author preferable as that usually calls for high inventory levels. As the thyristor was chosen as a suitable case representative because of its long lead time and high price, it should be suitable to manage by a consignment stock. Furthermore, the customers’ demand for the thyristor varied during the year of 2015. As has been visualised in Figure 23 the demand during the middle of the year was lower than expected, which lead to increased stock levels and it took a couple of months to get the inventory level back to normal. According to Battini et al. (2010a) high demand variations are another sign that consignment stock would be profitable to implement.

From a vendor’s perspective, implementation of a consignment stock can be profitable as well. As the supplier has access to all consumption data they can plan their own production more effectively. Furthermore, as an inventory space is placed inside the customer’s production site there is no need for the supplier to stock the goods at their own inventory. The inventory levels throughout the supply chain can therefore be reduced. (Battini et al., 2010a) The fact that this kind of inventory management requires a close relationship between the supplier and its customers also creates a more reliable position for the vendor as the customer will not change supplier as easy (Battini et al., 2010b). Thyristor supplier-A is currently one of the unit’s key suppliers and to continue to strengthen the relationship is likely interesting for them.

This case has proven that by taking purchase- and inventory costs into account when negotiation with suppliers, costs vary. How the different cost post varies in comparison to the current situation are visualised in Table 14. Changing inventory by implementing a consignment stock would, based on the performed calculations, increase the total cost. However, as the transportation cost is equal to zero for the current situation the potential for cost reduction with a consignment stock solution is still possible.

Table 14: Presentation of the results from case two, where the current situation is compared with one alternative scenario.

<table>
<thead>
<tr>
<th>Purchase cost</th>
<th>Transportation cost</th>
<th>Inventory costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current situation [SEK]</td>
<td>4 500 000</td>
<td>0</td>
<td>60 000</td>
</tr>
<tr>
<td>Consignment stock</td>
<td>↑ (2%)</td>
<td>Equal</td>
<td>↓ (93%)</td>
</tr>
</tbody>
</table>
6.3 CASE 3

The article that was chosen to represent case three is defined by a short lead time and a high net price, in coherence with Table 6. The article is a thermosetting resin, which is one of several necessary components to construct a contactor. The decisions to study this article were based on an ongoing evaluation regarding the possibility to adopt a dual-source solution or switch to another supplier. To evaluate both the current and alternative scenarios are therefore seen as an interesting case. (Strategic purchasers, 2016)

6.3.1 CURRENT SITUATION

The thermosetting resin detail is currently purchased and delivered from Thermosetting resin supplier-A, which produces plastic details in their factory in south of Sweden located almost 400 kilometres from Västerås. The supplier is a producing company, which focuses on refining raw material into plastic details ready for assembly. Once produced, the articles are placed in an inventory at Thermosetting resin supplier-A until an order is placed. Control Products is accountable for the distribution and trucks are used to transfer the goods to Västerås. The thermosetting resin details are then placed in inventory at Control Products while waiting for further assembling into contactors. (Strategic purchasers, 2016) Table 15 below presents the data foundation used for calculations. In similarity to the other cases, more detailed data concerning the consumption and demand has also been collected.

Table 15: Presentation of relevant data for further calculations regarding case three.

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly quantity</td>
<td>15 072 PC/year</td>
</tr>
<tr>
<td>Article weight</td>
<td>2.545 Kg</td>
</tr>
<tr>
<td>Duty expression</td>
<td>0 %</td>
</tr>
<tr>
<td>Transportation lead time</td>
<td>1 Day</td>
</tr>
<tr>
<td>Number of deliveries</td>
<td>182 Deliveries/year</td>
</tr>
<tr>
<td>Average delivered quantity</td>
<td>79 PC</td>
</tr>
<tr>
<td>Net price</td>
<td>87.14 SEK</td>
</tr>
<tr>
<td>Average stock level</td>
<td>316 PC</td>
</tr>
</tbody>
</table>

The purchase cost could be measured with the yearly quantity and the net price presented in Table 15 and the cost amounted to 1 300 000 SEK per year. The current situation will further be investigated by first the costs related to transport and thereafter the inventory costs.
TRANSPORT COST

As a result of purchasing from a supplier located within Sweden, the distance between the unit and Thermosetting resin supplier-A’s production is not far. The goods are distributed to Control Products by trucks. The transport itself only takes one day, which creates a high flexibility. Furthermore, Thermosetting resin supplier-A produces large batches and store finished products in their inventory. After the unit’s material planners have placed an order it will be ready for distribution within the next two days. An illustration over the thermosetting resin article’s way from the supplier to the unit’s production site is presented in Figure 25.

![Thermosetting resin supplier-A to Control Products]

2 days 1 day

Figure 25: An illustration over the thermosetting resin detail’s way from Thermosetting resin supplier-A to Control Products, where the lead time is three days.

The transportation cost occurs when the distributor sends invoices related to their transport service. The result of performed calculations showed the average cost for sending one thermosetting resin detail from Thermosetting resin supplier-A to Västerås amounts to two SEK per piece. During the year of 2015 this result generated a transportation cost of circa 30 000 SEK. As Thermosetting resin supplier-A is situated inside Sweden no custom has to be paid in order to collect the material and is therefore zero SEK.

INVENTORY COSTS

Control Products collaborates with Thermosetting resin supplier-A by providing them with one year prognoses in order to ease the supplier’s planning and ordering. The raw material needed to produce the thermosetting resin details are bought from an Italian supplier called Plastics supplier-A. Thermosetting resin supplier-A handles the ordering but they purchase on a contract negotiated by strategic purchasers at Control Products to optimize the net prices. The supplier produces the articles in advance and stores them at their own inventory in order to enable fast deliveries. Once an order is placed by the unit’s material planners it only takes three days until the articles are placed in stock at Control Products. (Strategic purchasers, 2016)
As it only takes one day to transfer the articles from the supplier to Västerås, the pipeline inventory cost is limited. Result from conducted calculation showed that during an average day of the year, an amount of circa 300 SEK is tied up in pipeline inventory cost.

To calculate the stock cost at Control Products, detailed data concerning the consumption and demand has been collected. The development of the stock level and the average stock level for the studied article is presented in Figure 26 for the year of 2015. As can be seen in the figure, the average stock level is about 300 pieces. The parameters to the stock cost for the studied article are presented in Table 15 above. The stock cost for the article is measured to 2 500 SEK and the inventory costs are therefore the summarisation of both pipeline inventory- and stock costs and amounts to 2 800 SEK.

![Image of stock level during 2015](image)

**Figure 26:** An illustration over the thermosetting resin detail’s inventory level during the year of 2015. The average stock level is also displayed in the figure.

### SENSITIVITY ANALYSIS

The result of the conducted calculations showed the purchase cost is most costly for the unit. As this cost has been calculated based on accurate numbers, there are no uncertainty regarding the value why an analysis is not necessary. Transportation cost is the second most costly post for the unit. In comparison to the stock costs, the transport cost is considerable larger why it is more reasonable to investigate further.

The transportation cost is based on a selection on invoices that was received during the year of 2015. As the trucks transported other goods apart from the specific thermosetting resin detail, a division of the total invoiced amount has been performed. Based on these factors an average cost per article has been calculated and used in order to determine the total transportation cost. However, the variation from the studied invoices result in a cost range from 1.41 to 3.02 SEK per article. How the minimum-, average- and maximum cost correlates with the yearly transportation cost are visualised in Figure 27.
6.3.2 ALTERNATIVE SCENARIOS

The alternative scenarios have been discussed with the SCM manager respective the Logistics & material manager in regard to case three and are to purchase the thermosetting resin detail from four alternative suppliers situated in Europe. Because Thermosetting resin supplier-A is currently a key supplier and a single source, alternative suppliers are investigated in order to press net prices. The four countries Finland, Estonia, Bulgaria and the Czech Republic were interesting to further investigate due to one strategic purchaser has started to ask for offered net prices from them. (SCM manager respective Logistics & material manager, 2016) Calculations and results will be described and presented for purchasing from all of the four countries below.

PURCHASE FROM OTHER COUNTRIES

Finland, Estonia, Bulgaria and the Czech Republic are viewed as interesting countries to buy thermosetting resin details from. Currently, Control Products only collaborates with the Thermosetting resin supplier-B situated in the Czech Republic from whom they buy different sizes of thermosetting resin details. Suppliers located in Finland and Bulgaria supply other ABB business units with thermosetting resin details and are therefore qualified suppliers. There are no current collaborations between any ABB business units and suppliers of thermosetting resin details in Estonia.
In order to determine the time it would take to transport the goods from the alternative countries, the material planners provided information regarding the normal transportation lead times from the countries Finland and Bulgaria. Transportation time from the Czech Republic could be extracted from SAP as purchase from Thermosetting resin supplier-B is currently conducted. The transportation lead time from Estonia was determined in coherence with the Logistics & material manager (2016) who had previous experience of buying products from Estonia. The defined transportation lead times are presented in Table 16.

ABB’s freight calculator has been applied for the countries Finland, Estonia and Bulgaria in order to calculate the transportation costs. Because the freight calculator limited the choices of cities from where the distribution could start from, the countries’ capitals have been used as starting points. The result showed a yearly transportation cost of circa 190 000 SEK from Finland, 210 000 SEK from Estonia and finally 320 000 SEK if the thermosetting resin details would be purchased from Bulgaria. To calculate the transportation cost for the alternative with purchase from Thermosetting resin supplier-B located in the Czech Republic, invoices referred to distribution of similar thermosetting resin details have been studied. During the year of 2015, two distributors were hired to transport the goods from the Czech Republic. By calculating the transportation cost for two other sized thermosetting resin details and assuming that the correlation between weight and cost would be the same for the case specific article, a transportation cost could be determined. The result of the calculations showed a yearly transportation cost of circa 170 000 SEK. A summarisation of all calculated transportation costs for the four alternative countries can be viewed in Table 16.

Because there are no concrete offers from any supplier acting on the four different countries’ markets, the alternative net prices are unknown. By comparing the current costs for purchase, transport and inventory with the parameters for the alternative scenario the breakeven net price could be measured. Because the current situation is cheaper in regard to the three cost posts, all alternatives have to offer a lower net price in order to generate the corresponding costs. The net prices also enabled determination of the yearly purchase costs. The results of the calculations are presented in Table 16 and all assumptions are displayed in Appendix 7.

Table 16: The table shows the lead time, transport cost, net price and purchase cost for the four countries that have been investigated as alternative scenarios for case three.

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Estonia</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport lead time [days]</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Transport cost [SEK/year]</td>
<td>190 000</td>
<td>210 000</td>
<td>320 000</td>
<td>170 000</td>
</tr>
<tr>
<td>Breakeven net price [SEK/PC]</td>
<td>76.80</td>
<td>74.93</td>
<td>67.97</td>
<td>77.57</td>
</tr>
<tr>
<td>Purchase cost [SEK/year]</td>
<td>1 200 000</td>
<td>1 100 000</td>
<td>1 000 000</td>
<td>1 200 000</td>
</tr>
</tbody>
</table>
As a result of the increased transportation lead times, the average stock level had to be increased in order to cover for the extra uncertainty. The extra consumptions were discussed with Logistics & material manager (2016) and compared with the ones in case number one. Based on the assumptions presented in Appendix 7, the alternative regarding purchase from Finland and the Czech Republic would generate one day additional consumption in stock. Furthermore, purchase from Estonia was assumed to generate two days extra consumption in the unit’s stock and finally the alternative with Bulgaria would generate three days. The calculated average stock levels for the alternatives are presented in Table 17 together with the calculated pipeline inventory costs, stock costs and finally the total inventory costs.

Table 17: The table shows the average stock level and the inventory costs for the four countries, which are related to case three with alternative scenarios.

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Estonia</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average stock level</td>
<td>371</td>
<td>426</td>
<td>482</td>
<td>371</td>
</tr>
<tr>
<td>Stock cost [SEK]</td>
<td>2 500</td>
<td>3 000</td>
<td>3 000</td>
<td>3 000</td>
</tr>
<tr>
<td>Pipeline inventory</td>
<td>800</td>
<td>1 500</td>
<td>2 000</td>
<td>800</td>
</tr>
<tr>
<td>Total inventory cost</td>
<td>3 300</td>
<td>4 500</td>
<td>5 000</td>
<td>3 800</td>
</tr>
</tbody>
</table>

SENSITIVITY ANALYSES

The result from the freight calculator is based on article specific data as well as information regarding the distance of the transport. Because only the capitals from the alternative countries could be set as starting points for the transportation, the actual results could differ a bit. In order to investigate how big impact the distances have on the yearly transportation cost, the cost per pallet has been varied with a ten percent increase and decrease. The results of the sensitivity analysis are visualised in Figure 28 together with the costs for the current situation.

Figure 28: An illustration of how changing transport cost on one pallet affect the transport costs for the alternative scenarios for case three. The figure also includes the transport cost for the current situation.
By varying the transport cost per pallet, the sensitivity analysis shows the differential between the increased- and decreased cost is bigger for the Bulgaria alternative than for the alternatives with Finland and Estonia. As a result of the longer distance, the Bulgarian alternative differs with a yearly cost of circa 63 000 SEK, which can be compared with circa 40 000 SEK difference for the two other alternatives. According to the conducted sensitivity analysis, purchase from Bulgaria cause bigger differences if the costs from the freight calculator would differ compared with purchasing from Finland and Estonia. The sensitivity analysis also showed an increase or decrease of the transport cost on one pallet would not be cheaper than the transport cost for the current situation.

The transportation cost for the alternative scenario with purchase from the Czech Republic was calculated by studying invoices for similar articles, distributed from the same country. Because the articles are not identical with the studied thermosetting resin detail and a limited number of invoices were examined, the calculated transport cost per piece was approximated. By varying the calculated cost of eleven SEK per pieces with both a ten and 20 percent increase and decrease, the parameter’s impact on the yearly transportation cost is investigated. The sensitivity analysis showed that the yearly cost difference would be circa 70 000 SEK between the decrease and increase with 20 percent, see Figure 29 compared with the cost for the alternative scenario. The figure also shows that with an increase or decrease, the cost for the current situation would be the cheapest any way.

Figure 29: An illustration of the sensitivity analysis concerning how the transport costs per pieces would change with both an increasing and decreasing cost with 10 % and 20 % for case three.
6.3.3 CASE ANALYSES

Case three included calculations and analyses regarding both the current situation, where the thermosetting resin detail is bought from a Swedish vendor, and alternative scenarios where the suppliers are replaced by another located in Finland, Estonia, Bulgaria or the Czech Republic. Previous collaboration between relevant suppliers located in Finland and Bulgaria and ABB business units ensure that these suppliers are qualified according to ABB’s demands. In Estonia there is no collaboration with any supplier nowadays and according to Narasimhan et al. (2006) establishing a new collaboration with a supplier would be time consuming. Upholding a relationship is also costly but a successful collaboration has big potential for future profits (Saunders, 1997). The collaboration between other ABB business units and thermosetting resin detail suppliers in Finland and Bulgaria would likely ease a potential future collaboration with Control Products as well. The Czech Thermosetting resin supplier-B is already involved as a supplier to the unit, why that collaboration is established. For all suppliers, evaluations are however necessary to determine if they are able to produce the wanted sizes of thermosetting resin details.

According to performed calculations, the transport costs would be increased with all the other scenarios compared with the current situation, which can be seen in Figure 30. The increased costs depend on the extended distance between the suppliers and Control Products. Bulgaria, which is located farthest is as a consequence the most expensive alternative scenario in regard to transportation cost while the other alternatives are quite similar. In comparison to the current situation the transportation cost would increase with circa 160 000 SEK for the alternative with Finland, 180 000 SEK for Estonia, 290 000 SEK for Bulgaria and finally 140 000 SEK for the Czech Republic. This is an increase with a factor between five to ten times compared to the current transport cost. The sensitivity analyses presented in subchapter 6.3.2 – Alternative scenarios showed that the even though the transportation costs would vary the transport cost for the current situation would be lower than any other alternative scenario.

Because all alternative scenarios were calculated based on the breakeven point, the alternative net prices reflect offers that would generate the corresponding cost as for the current situation. With a current net price of about 87 SEK per piece, the alternatives scenarios’ net prices are presented in Figure 30. As a result of the increased transport- and inventory cost, all alternatives’ net prices have to be lower than currently offered by Thermosetting resin supplier-A. Purchasing from Bulgaria would demand a net price reduction and therefore also purchasing cost of almost 22 percent and from all the other countries just over ten percent would be necessary in order to correspond to the current purchase cost. The sensitivity analysis showed that there would only be marginal differences in net prices even if the transport costs were to vary.
The found correlation between transportation cost and distance is supported by the theories presented by Van Weele (2012). According to the author, purchasing from international suppliers is often done in order to achieve low prices, which will cover the increased transportation cost. In order to lower the total cost it is important to take transport cost into account when choosing suppliers (Baily, 1997). The plausibility for Control Products to receive lower net price offers are likely high but these have to be compared to the increased transportation cost in order to save money.

Switching to a supplier situated further away generates longer transportation lead times. The high pressures on companies to offer fast deliveries (Coyle et al., 2013) could as a consequence be harder to deal with. Another aspect that is affected by longer lead times is the flexibility. As the lead times increase, the flexibility is reduced and more planning is therefore demanded. (Nilsson, 2000) The flexibility for a supplier to change the purchasing volumes is important when evaluating supplier (Lee & Drake, 2010; Mei-Ying & Yung-Chien, 2010; Shen & Yu, 2012) and therefore has to be taken into account. The current setup where Thermosetting resin supplier-A produces in advance should not be a service that is taken for granted.

From an environmental perspective it is also likely that the impact would increase with purchase from an extended distance (Nilsson, 2000). Another plausible outcome of switching from a national to an international supplier is more challenging communication. However, because ABB is a global actor this should not cause any big obstacles.

The alternatives’ stock costs, presented in subchapter 6.3.2 – Alternative scenarios, amounts to circa 3 000 SEK for Estonia, Bulgaria and the Czech Republic and 2 500 SEK for Finland. It is only small differences for the three mentioned countries compared to the current stock cost on 2 500 SEK. The pipeline inventory costs differ a bit more as they are calculated based on the transportation lead times and net prices, which varies between the setups. As there are currently initiatives to reduce the unit’s inventory cost (Inventory specialist, 2016), these
increased costs should be taken into account when the alternative suppliers are evaluated. The inventory costs and the transportation lead times are presented in Figure 31.

Figure 31: An illustration of the inventory costs and transportation lead times for the current situation and the alternative scenarios.

Based on performed calculations and analyses it can be said that the profitability with applying the alternative scenarios depends on which net prices that are offered by the suppliers. The measured net prices for the alternative scenarios would be acting as guidelines for the strategic purchasers when they might achieve offered net prices for potential suppliers in the respective country. Table 18 shows a compilation of the purchase-, transport-, inventory and total costs for the current situation and the related alternative scenarios. For the entire alternative it would be a decrease of the purchase cost and the transport and inventory costs would increase. As has been mentioned previously, due to the net prices have been measured to be a breakeven solution based on the costs for the current situation, the total costs are the same for the alternative scenario as can be seen in the table below.

Table 18: A presentation of the results related to case three when the costs for the current situation are compared with four alternatives.

<table>
<thead>
<tr>
<th></th>
<th>Purchase cost</th>
<th>Transport cost</th>
<th>Inventory costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current situation</td>
<td>1 300 000</td>
<td>30 000</td>
<td>2 800</td>
<td>1 332 800</td>
</tr>
<tr>
<td>Finland</td>
<td>↓ (12%)</td>
<td>↑ (513%)</td>
<td>↑ (21%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Estonia</td>
<td>↓ (14%)</td>
<td>↑ (603%)</td>
<td>↑ (51%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>↓ (22%)</td>
<td>↑ (948%)</td>
<td>↑ (66%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>↓ (11%)</td>
<td>↑ (475%)</td>
<td>↑ (23%)</td>
<td>Equal</td>
</tr>
</tbody>
</table>

The result concerning case three, provided that the calculated net prices can be obtained, is the net price has to be decreased so much so it covers for the increased costs for the transport- and inventory. If it also would be possible to achieve lower net prices than the ones presented above, it will be a profitable solution compared with the costs for the current situation.
6.4 CASE 4

According to Table 6 the article that represent case four is defined by a short lead time and a low net price. In order to enable a comparison between two similar products, another thermosetting resin detail, was chosen as a suitable article. In similarity to the previous case this article is purchased from Thermosetting resin supplier-A and it is a component in a contactor. This article is however both smaller and cheaper which is expected to impact the transportation- and inventory costs why the case is interesting to investigate further. An additional factor that supported the choice was this article, in similarity to the previous case, is being evaluated in regard to implement a dual-source solution or switch to another supplier. (Strategic purchasers, 2016)

6.4.1 CURRENT SITUATION

As mentioned in the previous case, the supplier is situated in south of Sweden. Thermosetting resin supplier-A buys raw material from Plastics supplier-A in Italy and produce articles based on the one year prognosis provided by Control Products. Producing in advance and storing the articles at the suppliers inventory, enables them to offer a short lead time. When an order is placed, the supplier collects the wanted articles and send them to the unit by trucks. Once they have arrived they are placed in the inventory at Control Products until demanded by the production. (Strategic purchasers, 2016) Calculations regarding the current costs have been done by using the data foundation presented in Table 19. Additional data regarding consumption and demand have also been collected.

Table 19: Presentation of relevant data for further calculations regarding case three.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly quantity</td>
<td>36 138</td>
<td>PC/year</td>
</tr>
<tr>
<td>Article weight</td>
<td>0.735</td>
<td>Kg</td>
</tr>
<tr>
<td>Duty expression</td>
<td>0</td>
<td>%</td>
</tr>
<tr>
<td>Transportation lead time</td>
<td>1</td>
<td>Day</td>
</tr>
<tr>
<td>Number of deliveries</td>
<td>174</td>
<td>Deliveries/year</td>
</tr>
<tr>
<td>Average delivered quantity</td>
<td>200</td>
<td>PC</td>
</tr>
<tr>
<td>Net price</td>
<td>37.10</td>
<td>SEK</td>
</tr>
<tr>
<td>Average stock level</td>
<td>920</td>
<td>PC</td>
</tr>
</tbody>
</table>

With the net price and the yearly quantity presented in Table 19 the purchase cost was calculated to be circa 1 300 000 SEK per year for the current situation. The result and additional information concerning transport- and inventory costs are presented below.
TRANSPORT COST

The transport situation of this thermosetting resin detail is no different than the one presented for case three. As mentioned, trucks transport the articles, which takes one day. As Thermosetting resin supplier-A produces in advance, the production lead time is two days and the transport lead time is one day. An illustration over the articles flow was presented in Figure 25, found in the earlier subchapter 6.3.1 – *Current situation*. Calculations over the transportation cost showed that the average cost for sending one thermosetting resin detail amounts to 0.64 SEK per piece. During the year of 2015 the total transportation cost resulted in circa 23 000 SEK. As the supplier is situated inside Sweden no custom has to be paid in order to collect the material and is therefore zero SEK.

INVENTORY COSTS

What differs this article with the previous case is mainly the size and net price. The inventory costs will be affected by the net price, as they are not as expensive to keep in inventory. Calculations over the pipeline inventory cost resulted in an average daily cost of 300 SEK. Furthermore, once placed in the unit’s inventory the goods tie up capital. In similarity to the previous cases, an investigation regarding the stock level’s development during the year of 2015 has been compiled. In Figure 32 below the result is shown and the average stock level has been marked. The conducted calculations indicate an average stock cost of circa 3 000 SEK and the average stock level consist of 920 pieces. The total inventory costs would be 3 300 SEK.

![Graph showing stock level during 2015](image)

*Figure 32: An illustration over the thermosetting resin detail’s inventory level during the year of 2015. The average stock level is also displayed in the figure.*

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SENSITIVITY ANALYSIS

In similarity to the previous cases, the transport cost is the second largest post that Control Products is charged for in regard to purchasing the studied article. Because the purchase cost during the year of 2015 is based on accurate numbers there is no need to perform a sensitivity analysis over the result.

The cost per thermosetting resin detail was based on invoices that included several different articles. Based on the studied article’s weight, a division of the total invoiced amount could be calculated. The average cost, received after studying several invoices, was calculated to 0.64 SEK per piece. The maximum value was however 1.26 SEK per piece and the minimum was 0.43 SEK per piece. The values effect on the yearly transportation cost is seen in Figure 33.

![Figure 33: An illustration over how the transportation cost per thermosetting resin detail affects the yearly transportation cost.](image)

The result from the sensitivity analysis shows that the difference between the maximum value and the minimum, on a year basis, is almost 30 000 SEK. There are however, only two invoices among several others that give a cost over one SEK per piece why the maximum value very rarely is reached. If the cost should increase to the maximum value and maintain that value during a year, the transportation cost would be doubled.
6.4.2 ALTERNATIVE SCENARIOS

Alternative scenarios have also been investigated for case four and they are the same as for case three as it was interesting to investigate how a cheaper and lighter article would affect the costs and the results. The calculations and the results concerning the purchase-, transport- and inventory costs will be described underneath.

PURCHASING FROM OTHER COUNTRIES

In similarity to case three mentioned in subchapter 6.3.2 – Alternative scenarios, the transportation lead time is three days from Finland and the Czech Republic, five days from Estonia and seven days from Bulgaria. In order to calculate the transportation costs, ABB’s freight calculator has been applied for the alternatives with Finland, Estonia and Bulgaria. Because of current collaboration with the Czech Thermosetting resin supplier-B, the alternative transportation cost for that alternative was determined by using current invoices related to similar thermosetting resin articles.

The calculated yearly transportation costs amounted to 140 000 SEK from Finland, 160 000 SEK from Estonia, 240 000 SEK from Bulgaria and 120 000 SEK from the Czech Republic. Because of the increased transport costs in comparison to purchase from Sweden, the offered net prices have to be lower than the current one. New net prices have been calculated by a breakeven method to compensate for the increased transport- and inventory costs, which also have influenced the yearly purchase costs. All alternative information is compiled in Table 20.

Table 20: The table shows the alternatives’ transportation lead time, transport costs, net price and the purchase costs.

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Estonia</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport lead time</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>[days]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport cost</td>
<td>140 000</td>
<td>160 000</td>
<td>240 000</td>
<td>120 000</td>
</tr>
<tr>
<td>[SEK/year]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakeven net price</td>
<td>33.98</td>
<td>33.35</td>
<td>31.16</td>
<td>34.47</td>
</tr>
<tr>
<td>[SEK/PC]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase cost</td>
<td>1 200 000</td>
<td>1 200 000</td>
<td>1 100 000</td>
<td>1 200 000</td>
</tr>
<tr>
<td>[SEK/year]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The increased stock levels are based on the same reasoning as for case three with its alternative scenarios and it means that the average stock level has increased with the numbers of consumptions for the article during one day with purchasing from Finland and the Czech Republic, two days for Estonia and three days for Bulgaria. The additional consumptions are from discussions with Logistics & material manager (2016) and comparison with the amounts of days in case one. The new net prices have changed the stock costs and pipeline inventory costs for respective country. All the costs and the average stock level are presented in Table 21.
Table 21: The table shows the average stock level and the inventory costs concerning case four.

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Estonia</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average stock level [PC]</td>
<td>1 054</td>
<td>1 187</td>
<td>1 321</td>
<td>1 054</td>
</tr>
<tr>
<td>Stock cost [SEK]</td>
<td>3 000</td>
<td>3 500</td>
<td>3 500</td>
<td>3 500</td>
</tr>
<tr>
<td>Pipeline inventory cost [SEK]</td>
<td>900</td>
<td>1 500</td>
<td>2 000</td>
<td>900</td>
</tr>
<tr>
<td>Total inventory cost [SEK]</td>
<td>3 900</td>
<td>5 000</td>
<td>5 500</td>
<td>4 400</td>
</tr>
</tbody>
</table>

SENSITIVITY ANALYSES

In order to determine the economic affect the cost for one pallet has on the yearly transportation cost, the cost has been varied with a ten percent increase and decrease in this sensitivity analysis. The cost per pallet was given by ABB’s freight calculator and the transport cost is illustrated in Figure 34 for the respective country and the current situation. The figure shows that for Finland the transport costs varies with almost 27 000 SEK per year from the lowest to the highest. The differences are over 31 000 SEK for Estonia and circa 47 000 SEK per year for Bulgaria. Bulgaria is therefore the alternative that is more affected by changing transport costs for one pallet and the other two countries are not that sensitive. But even if there would be an increase or decrease of the transport cost on one pallet, the costs related to the alternative scenarios would be higher than for the current situation.

Figure 34: An illustration of how changing transport cost on one pallet affects the transport costs for the alternative scenarios for case four. The figure also shows the comparison with the transport cost for the current situation.
The alternative scenario with purchasing from the Czech Republic has been investigated in the same way as for case three. The transport cost per piece was calculated based on transport invoices from the Thermosetting resin supplier-B. By letting the transport cost per piece vary with both an increase and a decrease of ten and 20 percent, the sensitivity analysis indicated the yearly transport cost could vary with circa 50 000 SEK compared with the decrease and increase with 20 percent, see Figure 35. The figure also shows that changing the transport cost per piece would bring higher costs for the alternative scenario than for the current situation.

Figure 35: An illustration of how the yearly transport cost is affected by a decrease or increase with 10 % respective 20 % of the transport cost per piece. The transport cost for the current situation is also showed in the figure.

6.4.3 CASE ANALYSES

The differences between case three and four are the costs, which are specific for each case and also for the different country alternatives. Because the two cases are so similar, the same theories have been used to analyse the result and will therefore not be repeated here. The current collaborations between Control Products and the alternative countries have also been analysed in subchapter 6.3.3 – Case analyses and will therefore not be further mentioned.

According to calculations the Bulgarian alternative would generate the highest transportation cost among the alternatives, see Figure 36. Compared to the current situation, the transport cost would increase with circa 210 000 SEK per year if a Bulgarian supplier was to be used. For the other alternatives the cost would increase with 110 000 SEK for Finland, 130 000 SEK for Estonia and finally 90 000 SEK from the Czech Republic. These results indicated an increase of transportation cost that is five to ten times higher than for the current situation. Seen from this perspective, purchasing from the Czech Republic would be the cheapest. Even though the transportation cost would vary, the sensitivity analysis presented in subchapter 6.4.2 –
Profitable negotiations

Alternative scenarios showed the current situation would have the lowest transportation cost compared with the four alternative scenarios.

Because of the increased transport- and inventory costs for the alternative scenarios, the net prices have to be lowered for achieving corresponding costs as for the current situation. As can be seen in Figure 36, the current net price for the studied article is about 37 SEK per piece. Purchasing from Bulgaria would require a decrease with over 16 percent of the net price in order to reach a breakeven point. For the other alternatives the net prices would have be reduced with about ten percent in order to be a profitable alternative for the unit.

![The costs for the different scenarios](image)

Figure 36: An illustration of the transport- and inventory costs and the net prices related to the current situation and the alternative scenarios.

The inventory costs, see Figure 37, would be changed with purchasing from other countries because of the altered transport lead time, average stock level and net price. Compared with the current situation, total inventory costs would increase with over 60 percent for purchasing from Bulgaria and increased with almost 50 percent for Estonia. An increase with circa 20 percent is what purchasing from Finland or the Czech Republic would lead to. The increased inventory costs depend on the required higher average stock levels to cover for uncertainties with longer transport lead times.
Profitable negotiations

Case presentations and analyses

Figure 37: The figure shows the variation of stock costs, pipeline inventory costs and the transport lead times.

The measured costs for purchase-, transport- and inventory are presented in Figure 38 together with the total costs for the current situation and the alternative scenarios for case number four. In similarities with case three, the net prices have been calculated as a breakeven of when the alternative would be a profitable solution. The net price would instead be acting as guidelines when the strategic purchasers negotiate with suppliers in the investigated countries. If the net prices would be obtained, the purchase costs for the alternative scenarios would be lower than for the current situation. On the other hand, the transport cost would be an increase with five to ten times with the alternative scenarios and it depends on the purchase from suppliers situated in countries outside Sweden. The potential net prices for the alternative would generate an increase of the inventory costs for all the alternative scenarios compared with the current situation. The total costs would be equal to the current situation because of the breakeven of the net prices that have been calculated.

### Purchase cost

<table>
<thead>
<tr>
<th>Current situation [SEK]</th>
<th>Finland</th>
<th>Estonia</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current situation [SEK]</td>
<td>1 300 000</td>
<td>23 000</td>
<td>3 300</td>
<td>1 326 300</td>
</tr>
<tr>
<td>Finland</td>
<td>↓ (8%)</td>
<td>↑ (482%)</td>
<td>↑ (21%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Estonia</td>
<td>↓ (10%)</td>
<td>↑ (576%)</td>
<td>↑ (47%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>↓ (16%)</td>
<td>↑ (913%)</td>
<td>↑ (65%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>↓ (7%)</td>
<td>↑ (405%)</td>
<td>↑ (23%)</td>
<td>Equal</td>
</tr>
</tbody>
</table>

Figure 38: A presentation of the results related to case four when the costs for the current situation are compared with four alternative scenarios.

The result related to case four is the net price has to be decreased so it covers for the increased transport- and inventory costs to achieve a profitable solution.
6.5 FINAL ANALYSES

In order to determine some general guidelines that the strategic purchasers at Control Products can use when negotiating with suppliers, the gained results from the different cases will be compiled and compared. In coherence with the conducted literature review and interviews with employees at the unit, the two sub-criteria lead time and net price were defined as two important aspects to take into account when evaluating suppliers. Based on this foundation, the four different cases were established in order to determine how purchase-, transport- and inventory cost were affected by different setups that were negotiated by the units strategic purchase department. Furthermore, the specific articles’ setup were currently evaluated to be changed why an insight in both their current- and alternative setup were requested. In Table 22 the cases’ variation of properties in regard to lead time and net price are presented together with the chosen case representative articles.

Table 22: A presentation over the chosen case articles and their defining properties.

<table>
<thead>
<tr>
<th>Case</th>
<th>Lead time</th>
<th>Net price</th>
<th>Chosen article</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>Long</td>
<td>High</td>
<td>Circuit board</td>
</tr>
<tr>
<td>Case 2</td>
<td>Long</td>
<td>High</td>
<td>Thyristor</td>
</tr>
<tr>
<td>Case 3</td>
<td>Short</td>
<td>High</td>
<td>Thermosetting resin detail</td>
</tr>
<tr>
<td>Case 4</td>
<td>Short</td>
<td>Low</td>
<td>Thermosetting resin detail</td>
</tr>
</tbody>
</table>

By calculating the purchase-, transport- and inventory costs for each case’s current situation and their alternative scenarios, the effect different setups have on the costs could be visualised. In order to enable more general conclusions, several cases had to be evaluated. Table 23 below presents a summarised view over the results from the studied cases. How different setups affect the purchase-, transport- and the inventory costs for each case are presented together with the total costs. How a setup’s profitability can be changed based on purchase-, transport- and inventory costs are thereafter evaluated.
Table 23: A compilation over the cases’ results in form of purchase-, transport-, inventory- and total costs.

<table>
<thead>
<tr>
<th>Setups for each case</th>
<th>Purchase cost</th>
<th>Transport cost</th>
<th>Inventory costs</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current situation [SEK]</td>
<td>5 000 000</td>
<td>406 000</td>
<td>66 000</td>
<td>5 476 000</td>
</tr>
<tr>
<td>Boat alternative</td>
<td>Equal</td>
<td>↓ (67%)</td>
<td>↑ (139%)</td>
<td>↓ (3%)</td>
</tr>
<tr>
<td>Poland alternative</td>
<td>↑ (2%)</td>
<td>↓ (68%)</td>
<td>↓ (0%)</td>
<td>↓ (3%)</td>
</tr>
<tr>
<td><strong>Case 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current situation [SEK]</td>
<td>4 500 000</td>
<td>0</td>
<td>60 000</td>
<td>4 560 000</td>
</tr>
<tr>
<td>Consignment stock</td>
<td>↑ (2%)</td>
<td>Equal</td>
<td>↓ (93%)</td>
<td>↑ (1%)</td>
</tr>
<tr>
<td><strong>Case 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current situation [SEK]</td>
<td>1 300 000</td>
<td>30 000</td>
<td>2 800</td>
<td>1 332 800</td>
</tr>
<tr>
<td>Finland</td>
<td>↓ (12%)</td>
<td>↑ (513%)</td>
<td>↑ (21%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Estonia</td>
<td>↓ (14%)</td>
<td>↑ (603%)</td>
<td>↑ (51%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>↓ (22%)</td>
<td>↑ (948%)</td>
<td>↑ (66%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>↓ (11%)</td>
<td>↑ (475%)</td>
<td>↑ (23%)</td>
<td>Equal</td>
</tr>
<tr>
<td><strong>Case 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current situation [SEK]</td>
<td>1 300 000</td>
<td>23 000</td>
<td>3 300</td>
<td>1 326 300</td>
</tr>
<tr>
<td>Finland</td>
<td>↓ (8%)</td>
<td>↑ (482%)</td>
<td>↑ (21%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Estonia</td>
<td>↓ (10%)</td>
<td>↑ (576%)</td>
<td>↑ (47%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>↓ (16%)</td>
<td>↑ (913%)</td>
<td>↑ (65%)</td>
<td>Equal</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>↓ (7%)</td>
<td>↑ (405%)</td>
<td>↑ (23%)</td>
<td>Equal</td>
</tr>
</tbody>
</table>

With today’s competitive market, it is not enough to offer customer low net prices, fast deliveries are also demanded (Coyle et al., 2013). Offshoring production to development countries generally results in enhanced transportation costs based on the increased distance between customer and supplier. Usage of fast modes of transportation, such as air transportation, is generally viewed as an attractive way to reduce the transportation lead time and increase flexibility (Björklund, 2012). To avoid rapid increment of the costs for transportation, only low-weight products with big order quantities are recommended for air transportation (Nilsson, 2000; Pewe, 2002). From a cost perspective, air transport is still an expensive option to transport goods (Nilsson, 2000). The conducted study confirms the theory in regard to both cost and lead time. Air transportation has been proven to be more expensive.
with the double amount in comparison to sea transportation, even though the studied article matches the preferred properties for air transportation. The downside with sea transportation is the increased transport lead time. However, if the goods are sent in the same frequency as with air transportation and the unit’s stock is expanded to cover for the extra uncertainties, it would still reduce the total cost distinctly. Choosing the cheaper alternative would likely also provide positive environmental effects (Pewe, 2002). By adding transport cost as a subject for future negotiations, case one’s alternative setup showed that the total costs could be reduced.

The unit’s strategic purchasers always aim for signing with the supplier that can offer them the lowest net price, because a cost reduction in regard to purchase cost is what the department is measured on (Strategic purchasers, 2016). This approach is far from unusual (Baily, 1997; Chen & Yang, 2003) and has led to many companies have increased their purchase from Asia (Van Weele, 2012). Based on the results provided by this study, it can be said that purchasing from suppliers far away is not always the most profitable set up. Purchasing from nearby suppliers situated in Europe indicated potential to lower transport- and inventory costs as a result of the reduced transport distances and risks. Case one’s alternative setup with purchasing from Poland showed therefore that even though the net price is higher than for the current situation, the total profitability of the setup is still better for the alternative setup.

Because the unit’s ordering placements are made by the material planners who are pressured to never get shortage, the inventory levels tend to be higher than necessary (Material planners, 2016). Adding the high net prices to the high inventory levels, the unit’s stock costs are high for these kinds of articles. With a consignment stock solution, the suppliers would receive more information regarding consumption and inventory levels from the unit. With the additional information and a given storage place at the unit, the suppliers will be able to better plan their production and reduce their own inventories. However, even though case two’s alternative scenario showed huge potential in lower inventory costs the total cost increased marginally as a result of the increased purchase cost that were generated by the higher net price. This indicates that in the same manner that the purchase cost might not be enough to reflect the total costs, either would a look at only the inventory costs be.

Furthermore, the results from case three and four’s alternative setups showed a similar pattern, with the only different in regard to the cost posts’ sizes. Replacing a geographical close supplier with one that is located further away would generate significant increased transport- and inventory costs. Purchasing from the international markets, bring more transportation of goods (Van Weele, 2012), which tend to result in increased transport costs (Björklund, 2012). To purchase products from countries outside Sweden would according to the study’s results cause longer transport lead time because of the longer distances between the suppliers and Control Products. It also results in increased inventory costs because of the higher levels of stocks that are required for longer transport lead times. In order to cover for
these increased transport- and inventory costs, the study indicated that the net price was required to be distinctly reduced. The net prices are as mentioned the most prioritised sub-criteria when the strategic purchasers negotiate with the suppliers (Strategic purchasers, 2016). According to Van Weele (2012), purchasing from developing countries can bring lower net prices. As a conclusion it is therefore seen as a plausible outcome that the negotiated net prices for the studied alternative setups could be reduced. However, in order for the alternative setups to be profitable the reduced net prices, which impacts the purchase cost must cover for the significant increased transport- and inventory costs. The comparison between case three and case four showed that it will bring the same conclusion regardless if the weight or the net price would differ. The amount of the costs would be the one that differ with other net prices and weight on the articles.

To summarise, the conclusions from the conducted cases showed by taking transport- and inventory costs into consideration when different setups are evaluated the result would differ compared to if only purchase cost was evaluated. A setup can be profitable even though the purchase cost is increased and a big reduction in the inventory costs are not necessarily enough to make a setup profitable. Finally, when potential suppliers are evaluated it has been shown to be of great importance to not neglect that the transport- and inventory costs can be increased significant even though the purchase cost is reduced. Making sure the chosen setup is the most profitable requires therefore that purchase-, transport- and inventory costs are taken into consideration when the strategic purchasers are negotiating with suppliers in the future.
CONCLUSIONS

This section contains the conclusions that have been established from this conducted study. Starting with a brief recap over the study’s purpose, the section then presents the results and conclusions gained from the four studied cases. The section ends with a recommendation related to the study’s purpose.

The following purpose has been defined in the study to gain more profitable negotiations at ABB’s unit Control Products.

The study’s purpose is to recommend future guidelines for the strategic purchasers at ABB’s unit Control Products that can be applied when negotiating with suppliers, by evaluating purchase-, transport- and inventory costs.

In order to investigate how the costs related to purchase-, transport- and inventory were affected by different setups, which was defined as the way the collaboration between the unit and its supplier is designed, four different cases were analysed. The defined cases consisted of specific articles that were chosen both for their varying properties, in regard to net price and lead time, and also for their current and alternative setups. By calculating the purchase-, transport- and inventory costs for the case articles' current situations, an insight in the current setups were gained. Furthermore, alternative scenarios that were already up for discussion at the unit were calculated. How the cost posts were affected, both separately and together, by different setups could then be determined.

Case one and case two were both based on articles with the properties of having a long lead time and a high net price. Because the unit found this combination of properties to be extra interesting, two cases were chosen to further investigate how products with these properties were effected by different setups in regard to purchase-, transport- and inventory costs. A circuit board, purchased from China and distributed by air transportation, was chosen to represent case one. The current situation was compared with two alternative setup scenarios that had been up for discussion. Changing mode of transportation, from airplanes to boats, showed to not affect the purchase cost, distinctly reduce the transport cost and significantly increase the inventory costs. Based on a summarised view regarding the alternative, the setup would generate a cost reduction of three percent if it would be implemented. The other alternative scenario included a supplier replacement where an alternative vendor, located in Europe, was investigated. This setup was to primarily reduce transport cost but also slightly inventory cost as a result of purchasing from a supplier located geographically closer. However, the purchase cost was expected to increase which from a strategic point of view is not wanted. The case’s alternative setup did however proved that even though the net price, and consequently the purchase cost, was increased the total cost would decrease with three percent compared to the current situation. Neglecting to evaluate transport- and inventory costs would therefore result in a less profitable setup for the unit.
Case two was represented by a thyristor with similar properties as the previous circuit board but the setup differed. By comparing the current situation with an alternative scenario where a consignment stock would be implemented, purchase-, transport- and inventory costs could be determined and evaluated. If the inventory setup would be exchanged to a consignment stock, the inventory costs for the specific thyristor would be reduced with circa 93 percent. However, the conducted study showed that even though big cost saving could be gained from an inventory perspective, the total costs would still slightly increase as a result of the increased net price. This indicated that it is not enough to only focus on one cost post as different setups affect other costs as well.

The research continued with case three and four, which were represented by two different thermosetting resin details, bought and distributed from a Swedish supplier. The study showed that there are small differences on how low or high net prices affect the results when the lead time is short. Four different alternative scenarios were analysed in regard to see if there would be a more profitable setup to purchase from suppliers situated outside Sweden. The results indicated an increase with five to ten times of the transportation cost compared to the current situation. The results also indicated higher inventory costs because of the longer transportation lead time and increased risks. These significant increased transport- and inventory costs put pressure on the net price, and consequently the purchase cost, to be reduced compared to the current situation. This cases' alternative setup have therefore proven that in order to establish more profitable setups than the one currently used, the reduced purchase cost has to cover for the increased transport- and inventory costs. The results also showed the differences in weight and net price for the two cases only affected the amount of costs for purchase, transport and inventory and the same conclusion could be drawn.

Based on the results provided from the four different cases, this study has proven that by also taking transport- and inventory costs into consideration when different setups are evaluated the displayed profitability would differ compared to if only purchase cost was evaluated. Collecting more information regarding different setups has shown that even though the purchase cost increases the total purchase-, transport- and inventory costs can decrease. If one cost post would significantly be reduced, an alternative setup could still be less profitable than the one currently used. The study has also shown that it is important to not neglect that the transport- and inventory costs can increase significant even though the purchase cost is reduced. The recommendation to Control Products is therefore that in order to ensure the chosen setup is the most profitable it is required that purchase-, transport- and inventory costs are taken into consideration. If the strategic purchasers at Control Products also evaluate transport- and inventory costs when they negotiate with suppliers in the future, more profitable deals can be obtained.
8 DISCUSSIONS

This section contains discussions about how circumstances affected the study, what new knowledge the unit has gained as a result of this study, the ethical and social aspects and finally suggestions on future studies.

8.1 CIRCUMSTANCES DURING THE RESEARCH

Because of unforeseen circumstances, all data that was planned to be collected were not possible to get access to. For case two the contract stated that a FCA-agreement had been negotiated, which meant that ABB should stand accountable for the distribution from the supplier to their production facility. It turned out this was not how the set up was handled in reality. Based on the fact that the transportation invoices were sent and paid by the supplier, the cost for transportation- and pipeline inventory equalled zero for the current situation. The research was adapted to this circumstance by focusing on the case’s current stock cost.

The transport invoices sent to Control Products were inadequate, which meant the cases’ current transport costs could not be calculated exactly. Given the information provided on the invoices, there were often difficult to determine which articles and sent quantities the invoices referred to. As a result of this circumstance, approximations of the transport cost had to be done. Better compatibility between invoices and SAP would enable more exact costs.

8.2 CONTRIBUTION WITH KNOWLEDGE TO CONTROL PRODUCTS

The main purpose with this report was to provide Control Products with recommendations that when applied would reduce costs for the unit. The compiled conclusions proved that net price should not be viewed as the only cost that matters in supplier negotiations. The costs for distribution and inventories also impact the profitability of different alternatives. Evaluating potential and current suppliers should therefore be done based on purchase-, transport- and inventory costs. The study has proven that the current management of these areas is not necessary the most profitable.

In addition to the study’s result, the unit has been provided with knowledge concerning the difficulties to connect specific articles with specific transportation invoices. Because of the lack of information on the invoices and limited correlation with SAP, finding exactly which articles that the invoices referred to were in many cases impossible. By gaining a better insight in the inbound transportation costs, the pricing can be more accurate. Furthermore, an extended insight would alert the unit of payment errors, which also was detected in this study.
8.3 ETHICAL AND SOCIAL ASPECTS

Sensitive information such as net prices, prices from distributors and names of the suppliers have been twisted in the report. This ethical aspect was made so the publicity of the academic report would not cause any damage for the company if the data and information would reach rivals to ABB. For ethical reasons, all statements from interviewed employees have also been presented anonymously. The persons´ names are presented in the report but in the text they are referred to via their titles.

If the unit will apply the compiled recommendations, some changes would have to be done in regard to how the employees go about their daily work. These social aspects should be taken into consideration before an implementation takes place. If the employees feel pressured or their workload was raised, they might act as obstacles in a potential future implementation.

8.4 SUGGESTIONS FOR FUTURE STUDIES

Because of the time limitation, the study only focuses on purchase-, transport- and inventory costs. These posts are however not the only ones that generates costs for the unit. One big post that has been excluded from this study is the overhead cost. Staring up new supplier collaborations, labour cost related to order placement, goods handling and negotiations are examples of relevant costs that could be interesting for further studies. Furthermore, the unit’s production facility has not been evaluated from a space perspective. Because of the limited spaces for stock keeping, the unit need to take this into consideration when choosing a setup.

Another suggestion for a future study is to investigate how the packaging material would have to be adjusted in order to secure safe and durable sea transportation. It is likely that goods have to be packaged differently depending on mode of transportation. In order to calculate a realistic cost for changing the way goods are distributed, this aspect should be included. Other similar aspects that could be investigated further are if the evaluated suppliers actually have the capacity and tools to produce the wanted product. Investments in these can otherwise be expensive and other alternatives could then be more profitable.

This study is only based on data from the year of 2015. In order to keep the recommendations up to date, continuous updates are recommended as concrete offers are collected and investigated. How the inventory levels for the different articles vary over time should also be updated accordingly. The data also has to be updated if the alternative scenarios change. How the results are affected by a dual source solution is an example of a suitable future study.
REFERENCES

PRINTED REFERENCES


Profitable negotiations


Profitable negotiations


**ELECTRONIC REFERENCES**


Profitable negotiations


VERBAL REFERENCES


Trade operations manager. (2016). Continuous contact with the Trade operations manager at Control Products with start in 29th of February 2016.
APPENDIX

Appendix 1 – The research questions ..................................................................................1
Appendix 2 – Interview questions to strategic purchasers ......................................................2
Appendix 3 – Literature review .............................................................................................3
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APPENDIX 1 – THE RESEARCH QUESTIONS

In this appendix, all the research questions and their subqueries are presented.

**Q1: How is the purchase cost affected by different setups?**

- **Q1.1:** What is the current purchase cost for respective case?
- **Q1.2:** What would purchase cost be for the cases’ alternative scenarios?

**Q2: How is the transport cost affected by different setups?**

- **Q2.1:** Which mode of transportation is currently used for respective case?
- **Q2.2:** What are the current transportation costs for respective case?
- **Q2.3:** Which modes of transportation would be plausible for the cases’ alternative scenarios?
- **Q2.4:** What would the transportation costs be for the cases’ alternative scenarios?
- **Q2.5:** What are the current costs of custom for respective case?
- **Q2.6:** What would the custom cost be for the cases’ alternative scenarios?

**Q3: How are the inventory costs affected by different setups?**

- **Q3.1:** What are the stock costs for the current situation for respective case?
- **Q3.2:** What would the stock costs be for other alternative scenarios for respective case?
- **Q3.3:** What is the current cost for the pipeline inventory for respective case?
- **Q3.4:** What would the cost for the pipeline inventory be for the cases’ alternative scenarios?

**Q4: Would Control Products benefit from extending their current focus on purchase cost to also include transport- and inventory costs in future supplier negotiations?**
APPENDIX 2 – INTERVIEW QUESTIONS TO STRATEGIC PURCHASERS

Several interviews with strategic purchasers were held and the questions and these are presented below.

- Which parameters do you take into account when selecting or negotiating with vendors?
- What are the challenges with buying your type of products?
  - How do you work to ease them?
- Which parameters do you negotiate with the potential and current vendors?
- How is the inventory setup concerning a specific supplier decided?
  - Do you receive suggestions from the vendors?
  - What do you aim for as a wanted setup?
  - Do you discuss alternative scenarios with other involved people?
- How is the transport setup concerning specific suppliers decided?
  - Do you receive suggestions from the vendors?
  - What do you aim for as a wanted setup?
  - Do you discuss alternative scenarios with other involved people?
- How much liberty do you, as a strategic purchaser, have and how much directives do you get from higher up in the company?
- Do you negotiate with different kind of terms with new respective old vendors?
- Are you able to make big changes or does that need approval from your boss?
- What do you do to follow-up the work performed by your current suppliers?
- How often do you meet your vendors and negotiate with new terms?
APPENDIX 3 – LITERATURE REVIEW

In this appendix the literature review with its keywords and number of matches will be presented. Table 24 presents the results from the research for supplier evaluation and Table 25 includes searching for consignment stocks.

Table 24: The search for supplier selection and evaluation and its five steps in the literature review.

<table>
<thead>
<tr>
<th>Literature review</th>
<th>Number of matches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps 1 and 2</strong></td>
<td></td>
</tr>
<tr>
<td>Strategic</td>
<td>835 023</td>
</tr>
<tr>
<td>AND Supplier capability</td>
<td>86 601</td>
</tr>
<tr>
<td>AND Supplier performance</td>
<td>58 964</td>
</tr>
<tr>
<td>AND Negotiation</td>
<td>11 080</td>
</tr>
<tr>
<td>AND Purchase</td>
<td>5 775</td>
</tr>
<tr>
<td>AND Material planning</td>
<td>2 914</td>
</tr>
<tr>
<td>AND Contract</td>
<td>2 422</td>
</tr>
<tr>
<td>AND Manufacturing</td>
<td>1 905</td>
</tr>
<tr>
<td>AND Supplier relationship management</td>
<td>1 582</td>
</tr>
<tr>
<td>AND Vendor selection</td>
<td>500</td>
</tr>
<tr>
<td>AND Supply chain management</td>
<td>379</td>
</tr>
<tr>
<td>AND Criteria</td>
<td>247</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>104</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>Title and subject</td>
<td>24</td>
</tr>
<tr>
<td>Abstract</td>
<td>12</td>
</tr>
<tr>
<td>The whole article</td>
<td>8</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>160225</td>
</tr>
</tbody>
</table>
Table 25: The search for consignments stocks and its five steps in the literature review.

<table>
<thead>
<tr>
<th>Literature review</th>
<th>Number of matches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps 1 and 2</strong></td>
<td></td>
</tr>
<tr>
<td>Stock management</td>
<td>594,956</td>
</tr>
<tr>
<td>AND Vendor-managed inventory</td>
<td>1,316</td>
</tr>
<tr>
<td>AND Inventory cost</td>
<td>1,092</td>
</tr>
<tr>
<td>AND Consignment</td>
<td>153</td>
</tr>
<tr>
<td>AND Suppliers</td>
<td>126</td>
</tr>
<tr>
<td>AND Consignment policy</td>
<td>74</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>50</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>Title and subject</td>
<td>18</td>
</tr>
<tr>
<td>Abstract</td>
<td>7</td>
</tr>
<tr>
<td>The whole article</td>
<td>4</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>160316</td>
</tr>
</tbody>
</table>
APPENDIX 4 – INTERVIEW QUESTIONS

The general questions asked to all the strategic purchasers are presented and followed by more case specific questions below.

- How is the article distributed from the supplier to this production site?
  - Is there any transhipments?
  - Where is the supplier situated?
  - Do you see any alternative options in regard to other transport setups?
    - If yes, why are they not implemented?
    - If no, why?
- What deal do you have with the supplier concerning inventory setups?
  - What is the minimised order quantity?
  - Who owns the inventory?
  - Where is the inventory located?
    - Are there any other options?
  - Do you see any alternative options in regard to other inventory setups?
    - If yes, why are they not implemented?
    - If no, why?
- What is the lead time?
  - Time from the supplier to Control Products?
  - Time to finish an order for the supplier?

Questions concerning case 1

- Which circuit board is suitable to represent a case where the lead time is long, high net price, high purchase volume and low weight on the article?
  - Which is the article’s number?
  - Why do you think this article is suitable?

Questions concerning case 2

- What is the article number for the thyristor where the lead time is long and there is a high net price?
  - Why do you think this article is suitable?

Questions concerning case 3

- What is the article number for the thermosetting resin detail where the lead time is short and there is a high net price?
  - Why do you think this article is suitable?
Questions concerning case 4

- What is the article number for the thermosetting resin detail where the lead time is short and there is a low net price?
  - Why do you think this article is suitable?
APPENDIX 5 - RESEARCH QUESTIONS AND INFORMATION SOURCES

In this appendix there is a presentation concerning the research questions and from whom or where the information was collected. Table 26 presents this information.

Table 26: A presentation over chosen method for answering the research questions.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Information source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1: How is the purchase cost affected by different setups?</strong></td>
<td></td>
</tr>
<tr>
<td>Q1.1: What is the current purchase cost for respective case?</td>
<td>SAP, Material planners</td>
</tr>
<tr>
<td>Q1.2: What would purchase cost be for the cases’ alternative scenarios?</td>
<td>Logistics &amp; material manager, SCM manager and strategic purchasers</td>
</tr>
<tr>
<td><strong>Q2: How is the transport cost affected by different setups?</strong></td>
<td></td>
</tr>
<tr>
<td>Q2.1: Which mode of transportation is currently used for respective case?</td>
<td>Strategic purchasers</td>
</tr>
<tr>
<td>Q2.2: What are the current transportation costs for respective case?</td>
<td>SAP, SIW, Trade operations manager and Supplier development engineer, Material planners</td>
</tr>
<tr>
<td>Q2.3: Which modes of transportation would be plausible for the cases’ alternative scenarios?</td>
<td>Logistics &amp; material manager, SCM manager and strategic purchasers</td>
</tr>
<tr>
<td>Q2.4: What would the transportation costs be for the cases’ alternative scenarios?</td>
<td>SAP, SIW, Trade operations manager and Supplier development engineer, Material planners</td>
</tr>
<tr>
<td>Q2.5: What are the current costs of custom for respective case?</td>
<td>Expeditors, Tullverket, SAP and Trade operations manager</td>
</tr>
<tr>
<td>Q2.6: What would the custom cost be for the cases’ alternative scenarios?</td>
<td>Expeditors, Tullverket, SAP and Trade operations manager</td>
</tr>
<tr>
<td><strong>Q3: How are the inventory costs affected by different setups?</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 5 - Research questions and information sources

<table>
<thead>
<tr>
<th>Question</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3.1: What are the stock costs for the current situation for respective case?</td>
<td>Material planners, SAP</td>
</tr>
<tr>
<td>Q3.2: What would the stock costs be for other alternative scenarios for respective case?</td>
<td>Material planners, SAP</td>
</tr>
<tr>
<td>Q3.3: What is the current cost for the pipeline inventory for respective case?</td>
<td>Material planners, SAP</td>
</tr>
<tr>
<td>Q3.4: What would the cost for the pipeline inventory be for the cases' alternative scenarios?</td>
<td>Material planners, SAP</td>
</tr>
<tr>
<td>Q4: Would Control Products benefit from extending their current focus on purchase cost to also include transport- and inventory costs in future supplier negotiations?</td>
<td>Results from previously calculations and theories</td>
</tr>
</tbody>
</table>
APPENDIX 6 – HOW THE ROUNDING WAS PERFORMED

All the calculated costs are rounded according to the range presented in Table 27 but the total costs for purchase, transport and inventory were summarised based on the rounded values. Even though the values are rounded when they are presented in the report, it is the actual costs that have been used during the calculations.

Table 27: A presentation of the used rounding system for the calculated costs.

<table>
<thead>
<tr>
<th>Value range [SEK]</th>
<th>Rounded to the nearest [SEK]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1 000</td>
<td>100</td>
</tr>
<tr>
<td>1 000 – 10 000</td>
<td>500</td>
</tr>
<tr>
<td>10 000 – 100 000</td>
<td>1 000</td>
</tr>
<tr>
<td>100 000 – 1 000 000</td>
<td>10 000</td>
</tr>
<tr>
<td>1 000 000 - ∞</td>
<td>100 000</td>
</tr>
</tbody>
</table>
To enable calculation of transport- and inventory costs for the respective cases, some assumptions had to be done. All assumptions, for the different cases, are presented in Table 28.

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Case 1 – Circuit board</th>
<th>Poland alternative</th>
<th>Boat alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>The order quantity is not affected by any alternative scenarios</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of deliveries is not affected by any alternative scenario</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The total truck transportation lead time amounts to two days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea transport from China takes the same time as from Thailand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four weeks extra consumption stock is needed to compensate the sea journey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The transport cost from Dongguan to the nearest airport is the same as from IMI’s production facility to the closest harbour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ferriage is assumed to be included in the transport costs from the freight calculator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two different distributors would be used to transport the goods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit board supplier-B would be the used supplier from Poland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A specific distributor would be used to transport the goods from Poland to Sweden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The circuit boards used in softstarters have the same measurements as the ones used in contactors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The correlation between weight and volume is the same between studied circuit boards for softstarters as for contactors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchasing from Poland would generate a net price of 8.23 EUR/PC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The stock level could be reduced with two days consumption when purchasing from Poland instead of China</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The cost per kilometres, given from the freight calculator, is the same no matter the distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eventually ferriage is assumed to be included in the transport costs from the freight calculator</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The cost to deliver pallets are assumed to be a linear function and therefore will not reduce depending on the sent pallet quantity

<table>
<thead>
<tr>
<th>Case 2 - Thyristor</th>
</tr>
</thead>
<tbody>
<tr>
<td>One extraction per week would be done when implementing a consignment stock solution</td>
</tr>
<tr>
<td>An extra charge of two percent of the total purchase cost would be added to the net price to compensate for transportation costs</td>
</tr>
</tbody>
</table>

**Case 3 & 4 – Thermosetting resin details**

| The order quantity is not affected by any alternative scenarios |
| The number of deliveries is not affected by any alternative scenario |
| The transport costs for one delivery have been assumed to increase linearly |
| The ferriage is assumed to be included in the transport costs from the freight calculator |
| The transportation lead time is assumed to be similar as for other goods that are transported from Finland, Bulgaria and the Czech Republic |
| The lead time for transport goods from Estonia is assumed to be five days |
| Thermosetting resin supplier-B would be the used supplier from the Czech Republic |
| The average stock levels would increase with one day’s consumption if purchasing from Finland or the Czech Republic, two days’ from Estonia and three days’ from Bulgaria |
| A specific distributor would be used to transport the goods from Finland, Estonia or Bulgaria to Sweden |
| A distributor was firstly used to transport the goods from the Czech Republic to Sweden but changed to another one in June 2015. |
| The correlation between the transport costs and the weight is assumed to be linear for the alternative with the Czech Republic. |