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Outsourcing spare part inventory management in the paper industry - A case study on Edet paper mill

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Abstract

The paper industry is a large-scale processing industry where a continuous production, around the clock is necessary. This means that it is necessary to carry an inventory of spare parts. This however comes with costs in the form of mainly cost of capital and handling costs. Inventory management is about balancing the cost of keeping inventory and the service level to the production. This study explores the possibilities of outsourcing the spare part inventory management at a paper mill. The study is a case study that uses a mixed-method approach. The study finds that by outsourcing the spare part sourcing and inventory control to a third-party logistics provider (3PLP) potential cost savings can be reached primarily by a more streamlined re-stocking process and taking advantage of specialization, aggregation and economics of scale. The major motive behind outsourcing is saving costs and making sure that the company can focus on value-adding activities and its core-competence. The items that are best suitable for an outsourcing solution is generic low-value items such as Tools, Utensils and Bearings.

Sammanfattning

Pappersindustrin är en storskalig processindustri där ständig production dygnet runt är nödvändig. Detta innebär att det är nödvändigt med ett reservdelslager. Detta kommer dock med kostnader i form av främst kapital- och hanteringskostnad. Lagerhantering handlar om att balansera servicenivån till production och kostnaden för lagerhållningen. Detta arbete undersöker möjligheterna för en outsourcinglösning för reservdelshanteringen på ett pappersbruk. Arbetet är en fallstudie som använder sig av flermetodsforskning. Genom att outsource reservdelsanskaffandet och dess lagerkontroll till ett tredjepartslogistikföretag kan potentiella kostnadsbesparing bli nådda genom främst en effektivare anskaffningsprocess. Detta genom att dra fördel av specialisering, aggregering och skalfördelar. Den stora anledningen till att pröva implementera en outsourcinglösning är kostnadsbesparingar och försäkra sig om att man kan ägna sig åt värdeadderande aktiviteter och fokusera på sin kärnverksamhet. Reservdelar mest lämpade för outsourcing är generiska delar av lågt värde såsom Verktyg, Förnödenheter och Hjullager.

Abbreviations

Short form	Long form	Page introduced
3PL	Third Party Logistics	1
3PLP	Third Party Logistics Provider	1
AHP	Analytic Hierarchy Process	9
EOQ	Economic order quantity	4
EPQ	Economic Production Quantity	1
ERP	Enterprise Resource Planning (system)	21
KPI	Key Performance Indicator	8
MCDM	Multicriteria Decision Making	10
MRO	Maintenance, Repairs, Operations	15
ROP	Re-Order Point	20
SCM	Supply Chain Management	5

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1 Introduction

Outsourcing is defined as: “The process of paying to have part of the company’s work done by another company” (Cambridge English Dictionary, 2019). Outsourcing is commonplace in both public and private organizations. Most companies outsource activities to achieve lower costs and better focus on core-activities (Kremic et al., 2006).

After the second World War and especially in the 70s and 80s the use of contractors grew and outsourcing was identified officially as a business strategy in 1989 (Rushton & Walker, 2007). By the mid 1990:s many companies had begun to shedding their non-core activities, the idea was to, as put by Peter Drucker: “Do what you do best, outsource the rest” (Vitasek, 2010). Third party logistics was also introduced in the mid-1990s in the UK when the shipping industry saw an opportunity to become a part of companies logistics operations, not just doing one-dimensional shipping (Rushton & Walker, 2007).

At the turn of the millennium logisticians believed that collaborative logistics where the way to go and evolve logistics in the supply chain, with continuous and real-time optimization and communication, one way of achieving this is by outsourcing these logistics activities (Frazelle, 2001).

The procurement of non-core production items, such as spare parts is increasingly becoming an area of companies interest for decreasing costs and the Third Party Logistics providers (3PLP) are in a unique position to provide logistics outsourcing for this items, generating effectiveness by combining logistics and freight management of multiple companies and to take advantage of aggregation of demand economics of scale. Small improvements in the spare part management may lead to substantial cost saving (Eaves & Kingsman, 2004).

A problem with spare part management is that while the standard questions of inventory management still have to be answered: Which parts, how many, where. Spare parts is not fully compatible with standard inventory management models like the EPQ model (Economic Production Quantity) since the characteristics of spare parts not satisfy the underlying conditions in those models (Botter & Fortuin, 2000). Compared to the inventory of input material and finished product the spare parts have an uneven and less predictable demand and can vary in value and importance. They are not a homogeneous group; some spare has a predictable ware pattern and fast turnover while some are expensive and critical but is almost impossible to tell when or if it will fail.

Today 3PL (Third Party Logistics) is widespread and according to the “Trends in 3PL and Customer Relationships 2017” report 90% of US fortune 500 companies rely on 3PLPs for logistics and Supply Chain Services, up from 46% in 2001 (Armstrong & Associates, 2017). The “2019 Third Party Logistics Study” shows that 22% of companies using 3PL uses it for inventory management (Infosys, 2019).

1.1 Problem background

In a processing industry interruption in the production is detrimental and will incur large costs. These companies are therefore keeping onsite supplies of spare parts. This ensures that the production can run smoothly and in the case of a crucial part failing it can be quickly replaced. Spare part management is a prerequisite for reliable plant operation, it is impossible to get around the issue of failing components without investing in spares (Sigma, 2017). Having this

inventory of spare parts does however not come for free, there is both cost of capital and handling cost for keeping this inventory. The purpose of spare part inventory management is therefore to limit the total value of items in inventory and effectivities in the process of procuring and handling them, while keeping a high service level ensuring that the production will run smoothly.

Traditional inventory control methods such as EPQ are however not applicable on the spare part inventory. The characteristics of spare parts does not satisfy the underlying conditions in those models, primarily because of the unpredictable and often sporadic demand (Botter & Fortuin, 2000).

Outsourcing might be a way a company can decrease their cost by leaving it to an external handler (3PLP) that is specialized in inventory management and can aggregate supplies from many customers. The company may also through outsourcing reduce administration cost that comes with ordering separately from different vendors. (Parashkevova, 2007, p. 29) puts it as: “The implementation of an up-to-date logistics management in companies provides more effectiveness. This means to use outsourcing.”.

The two main advantages of using outsourcing is cost reduction and possibility to focus on core competence. This is done by aggregating the demand and lowers the needed level of safety inventory (Chopra & Meindl, 2016). By shedding non-core process the company can focus on what its best at, and the resources gets re-allocated over the supply chain in a more efficient way by using a 3PLP that is specialized in inventory management and have it as its core-competence A 3PLP will also have more knowledge on inventory management and better systems and equipment for performing this function (Parashkevova, 2007).

The pulp and paper industry are a prime example of a processing industry where the goal is to keep a continuous production at all times, basically 24 hours a day, 365 days a year. Hence this is a relevant industry for studying the possibilities of outsourcing for spare part inventory management.

The decision of implementing outsourcing is however not automatic, without any considerations. There are risks with outsourcing, mainly loss of control and knowledge. Dun & Bradstreet's Barometer of Global Outsourcing (Hill, 2000) found that 20 to 25% of all outsourcing relationships fail within a two year period, mainly as the result of miscommunication. Hence it is of interest to acquire more knowledge on the outsourcing of spare parts, and the implementation process.

1.2 Aim

The aim of this study is to identify and describe the considerations that needs to be taken in the process of implementing an outsourcing solution for the spare part inventory management of a company in the pulp and paper industry, as well as presenting possible answers to those considerations.

1.2.1 Research Questions

The study aims to address the following research questions:

- What are the motives of wanting to outsource the spare part inventory management?
- What are the current cost drivers and how are they affected by outsourcing?

- What categories of items should be considered for outsourcing?
- What are the important factors in a successful outsourcing relationship?

1.3 Delimitations

To reach a depth in the understanding of the studied subject the study is limited to one case-company. The studied phenomenon is outsourcing of spare part management and its preparation. The operational inventory management of the host company or 3PLP is not studied in detail.

1.4 Literature review

The purpose of the literature review is to identify and understand existing information and knowledge on topics relating to the study. The most important tools for the literature search was Google Scholar, Web of Science and Uppsatser.se. Key search terms were: Outsourcing, Spare part management and Inventory management. Another important source of literature were the bibliographies of relevant studies.

There is a large number of studies on inventory management in different industries. Less has been published on specifically spare part management. Botter & Fortuin (2000) describes the difficulties and differences of spare part inventory management compared to regular inventory management through a case study on EDIAP, a multinational logistics organization. They conclude that spare part inventories cannot be managed by standard inventory control methods. Eaves & Kingsman (2004) emphasizes the importance of spare part management and analyzes the variations in demand and different methods for spare part forecasting through a case study on the UK: s Royal Air Force (RAF). Their main take-away is that the demand pattern is more unpredictable than for standard inventory, making forecasting and inventory control more difficult. Huiskonen (2001) has developed a framework for how to categorize parts by their characteristics and discusses their effects on a company's logistics network. Four different criteria are suggested: Criticality, Specificity, Demand pattern and Value.

Many researchers have focused on the effects of outsourcing logistics functions, the motives, benefits and risks. Kremic et al. (2006) made a literature review, analyzing the outsourcing literature. Parashkevova (2007) describes the development of third part logistics services and Rushton & Walker (2007) who in their book gives an extensive description of logistics outsourcing and its opportunities. A concise summary of their work is that logistics outsourcing has great potential, and might even be a requirement for staying competitive, but the selection of activities to outsource should be done with care to keep the right activities and core-competence within the company.

There is a lack of literature studying the intersection of logistics outsourcing and spare part inventory management, with the exception being Kivinen & Osasto (2002). They have written a report on the outsourcing process of spare parts in the metal industry. They also developed guidelines for the outsourcing process, with hints for both the tendering process, the implementation and what should be included in a successful contract. The most important points are: Open communication, clear mission and objectives and defining the different parties core-competences.

There is some master thesis, in the form of case studies that are tangential to the topic of this study. Ewetz & Fridell (2013) have conducted a caste study on Saab AB's (military defense and security manufacturer) support services and describes the characteristics of spare part

management and categorizes the spare parts in inventory in their development of an inventory management strategy. They found that the most impactful characteristics were low consumption and fortuitous frequency, and that a software tool is seen as necessary to enable an order point system. Häggmark & Whihelmsson (2013) have conducted a case study on Ålö AB (manufacturer in the agriculture industry) and through qualitative interviews studied the outsourcing of their spare part inventory and the potential effects on profitability and customer service. They conclude that first and foremost the motives for outsourcing are strategic, closely followed by cost control. They also identified risks that can lead to increased costs: Uncertainty, loss of control and a requirement to keep operational knowledge.

Burman & Ottosson (2012), Högberg *et al.* (2005) and Widler (2017) have all done case studies on the inventory management of spare parts in the pulp and paper industry. All these studies have a focus on the operative management and does not discuss strategic decisions such as outsourcing. They give suggestions on how to improve the inventory management while keeping it inhouse. Such improvements can be made by: Inventory classification, standardized work and knowledge transfer (including extended use of computer systems). They also iterate that classical inventory management such as EOQ (Economic order quantity) is not suitable for spare part inventory management.

To summarize, there are existing studies on both spare part management and logistics outsourcing but there is a knowledge-gap in the intersection of the two subjects. As stated above, there is case studies on inventory management in the pulp and paper industry, but they do not consider outsourcing. While the studies by Ewetz & Fridell (2013) and Häggmark & Whihelmsson (2013) incorporates outsourcing of spare part management, they do not do this from the perspective of an industry using spare part but from the perspective of the producers of spare parts. The study by Kivinen & Osasto (2002) is the closest to this study as its considers the procurement of spare parts in a processing industry, in their case study the finish metal industry as unit of analysis. Their study is also much more overlooking without getting into the specifics, giving more general advice on what to consider in the outsourcing process.

2 Theory

The following chapter presents theories and previous knowledge relevant to inventory management and outsourcing. The chapter gives a framework to relate the empirical findings to. It starts off with a broad description of what inventory management is in general and then the areas most relevant to the study and how the less homogeneous items that are spare part effect the inventory management. The chapter then presents theories relevant to the other aspect of the study, logistics outsourcing. Finally, the two principles for quantitative decision support are presented, the method for these are then specified in the method chapter.

2.1 Inventory management

Inventory management is a part in the broader topic of supply chain management (SCM) which addresses the supply process throughout the value chain (Tan, 2001). Inventory management deals specifically with what quantities of items should be kept in inventory and how often and in what quantities items should be reordered. This is typically done with methods like EOQ or EPQ (Huiskonen, 2001).

In addition to the purchase price of an item, costs for keeping inventory (holding costs), and handling shipments (ordering costs) needs to be considered (Chopra & Meindl, 2016). The purpose of an inventory management system is to ensure a desired service level with minimum capital investment and administrative costs (Huiskonen, 2001). These concepts are described further bellow.

2.1.1 Inventory holding cost

The holding cost consist of *cost of capital* – the opportunity cost of not being able to invest the capital elsewhere, and the *handling cost* – Expenses connected to the handling of items in inventory, ex inventory personnel, equipment, renting space (Chopra & Meindl, 2016).

2.1.2 Ordering cost

The ordering cost is expenses connected to each order or shipment of items. These costs can be further grouped into three categories: The *transportation costs*, the *receiving costs* – The cost of handling the items when they are delivered and putting them in their right spot, and *administrative costs* – Cost connected to putting orders, booking delivered items and handling invoices (Chopra & Meindl, 2016).

2.1.3 Safety inventory and service level

The safety inventory is needed so an uncertain demand does not lead to stockouts, the required safety inventory is a function of the uncertainty in demand, the lead time and the desired level of product availability (Chopra & Meindl, 2016). By having a large safety-inventory a higher product availability or service level can be reached but it also leads to higher holding costs. A safety inventory is necessary in all cases where the lead time for the item is longer than the tolerable time for a stockout (Huiskonen, 2001).

2.2 Spare part inventory management

While volume and value are control characteristics for all inventory management, what is special to spare parts is that for many items the demand is uncertain and often low and irregular.

Together with often high-value and critical items the amount of safety inventory needed is higher than if these characteristics did not exist (Huiskonen, 2001).

The items in the spare part inventory can usually be put in one of a few categories. Examples are Critical Spares, Spare parts, Consumables and Bulk commodities (Bailey & Helms, 2007) and Consumables, Generic spare parts, Specific spare parts, Strategic spare parts (Cavalieri *et al.*, 2008). Table 1 shows a summary of categories and their characteristics as identified in existing literature.

Table 1. A summary of the categories of spare parts identified in existing literature and their characteristics, (Bailey & Helms, 2007) and (Cavalieri et al., 2008)

Spare part category	Characteristic
Specific and Critical	High Value, highly specific to the company's production and cannot be replaced, needs to be replaced immediately in case of failure.
Generic Spare Parts	Available from multiple suppliers or manufacturers whose products is exchangeable.
Consumables	A steady consumption, many available suppliers.

Table 1 shows that of the three categories of spare that have been identified in the existing literature, "Specific and Critical" differs itself from the other two with its high value and low availability.

2.2.1 Categorizing spare parts in inventory

To be able to make decisions about inventory management and policies classification of items held in inventory is crucial. The need for classification is higher for spare part inventory management than inventory management in general as the items are less homogenous. When spare parts are managed in practice however, general inventory management principles are usually applied, without enough attention to the special characteristics of spare parts. Huiskonen (2001, p. 126) describes spare part inventory management as "a special case of general inventory management with some special characteristics".

For inventory control, especially for spare parts, developing clear criteria to help define and categorize spare parts is important for being able to make decisions (Sigma, 2017). Huiskonen (2001) presents four control characteristics of maintenance spare parts: Criticality, Specificity, Demand pattern and Value. These are described below in Table 2.

Table 2. The characteristics Huiskonen (2001) suggests for categorization of spare parts kept in inventory

Characteristic	Comment
Criticality	Related to the consequences on the production caused by failure of this part. Can be divided in terms of how quickly they can be delivered and the effect on the. They can be on a scale of very critical items that have to be available immediately in case of failure to non-critical items where spares do not have to be held in inventory and the time window for the item to be supplied is relatively long.
Specificity	How specific is the item is to the company's operations? Is it something very specific to the industry or a standard part used by companies in multiples sectors and available at many suppliers? The extreme case is user-specific items that are made to order. The other end of the spectrum is generic standard items such as bearings that are manufactured by many manufacturers and can be supplied by multiple vendors.
Demand Pattern	Includes the aspects of volume and predictability. There are however two broad categories: Items with random failure (unpredictable demand) and Items with a predictable wearing pattern (Smooth demand).
Value	The value (purchase price) of items.

The “Criticality” and “Specificity” are the characteristics in Table 2 that are of qualitative nature and requires expert opinion to be specified. “Demand Pattern” and “Value” on the other hand is based on sourcing data and can more easily be analyzed numerically.

2.3 Logistics Outsourcing

Papadopoulou, (2001, p. 32) defines logistics outsourcings as follows: “Logistics Outsourcing is the contracting of the management and operational control of logistics functions to unrelated third-party companies, the companies performing this service is called Third Party Logistics Providers” (3PLP). The reasons for logistics outsourcing working in theory are presented below, from the very concrete demand aggregation to the more intangible strategic focus.

2.3.1 Aggregating the demand

By aggregating the demand from many customers, a lower level of safety inventory is needed (Chopra & Meindl, 2016). Aggregation of the demand of items allows for significantly lower uncertainty within the supply chain. Huiskonen (2001, p. 130) specifically raises it in the perspective of spare parts as “a way to consolidate demand and reduce variability”. The effects are most significant when the demand is fragmented and uncertain, if this is the case the aggregation lowers the total inventory needed in the supply chain.

2.3.2 Specialization

By outsourcing to a third party that are further along the learning curve in regard to a activity in the supply chain it makes it possible for the parties to focus on their core-competence and improve the overall surplus (Chopra & Meindl, 2016). To be the best in their field the 3PLPs needs to constantly improve and be among the best in what they do, this includes using the best technology and solutions. It might not be economically feasible for a company in the processing industry to use and continuously update to the latest logistics technology. For the 3PLP that is specialized in logistics and drives larger volumes and can take advantage of economy of scale thanks to aggregating the demand of multiple industries it is both economically viable and necessary to have the latest equipment to stay competitive in the 3PL business (Parashkevova,

2007). And it is just not that they have the best technology, they have the know-how and the human resources to utilize it in the best way.

2.3.3 *Strategic focus*

Outsourcing is a choice that declines one process that is not in the company's core-competence. This process gets passed to an external company that is specialized in that process, i.e. have it as its core-competence. This way the supply chains resources gets re-allocated in a more efficient way (Parashkevova, 2007). By outsourcing non-core functions the company can improve its focus and thus performance regarding the value creating core-activities (Chopra & Meindl, 2016).

2.4 Vendor-managed inventory

Vendor-managed inventory (VMI) is a concept that means that the supplier on an item is responsible for all decisions regarding the inventory of the items they supply. They are not just delivering the items but does also physically restock and most importantly the inventory control is also the responsibility of the supplier. VMI can allow for profits along the supply chain, for both the supplier and user (Chopra & Meindl, 2016).

2.5 Key Performance indicators

A well-known saying is that “what get measured gets done”, meaning that measuring and reporting keeps focus on these metrics, leading to action that improves the measurements. Finding the right things to measure and have transparent communication is crucial for a successful outsourcing relationship.

A Key Performance Indicator (KPI) is an elevated metric, that is more critical and important for the company's success then other metrics. A KPI should measure something that is actionable and the used KPI:s should not be in conflict with each other where improving one leads to another performing worse. (Wolf, 2010).

A KPI does not indicate what the value should be, they can always improve and become better (higher or lower). A common approach is to focus on “spares inventory value improvement” with KPI such as: Total stock value, cost of keeping stock, critical spares stock-out, rate of circulation, inventory record accuracy (Lin & Ghodrati, 2011).

2.6 Risks of outsourcing

The risks with outsourcing is mainly the loss of control and knowledge, with the company loosing important knowledge of the outsourced items or processes and becomes reliant on a single 3PLP in the sourcing process (Parashkevova, 2007). The contact with the manufacturers might also become worse when using an intermediary (Chopra & Meindl, 2016). There is also a risk that the outsourcing relation work best in the beginning, that the contractor performs its best in the beginning to give a good impression but the initial extra effort might then peter out (Schwyn, 1999).

These problems of lost control can be mitigated by having a good information flow between the collaborating parties and inclusion of performance metrics in the contracts (Kivinen & Osasto, 2002). Dun & Bradstreet's Barometer of Global Outsourcing (Hill, 2000) found that of the failed outsourcing relationships that failed within a two year period 70% failed due to

mainly miscommunication and it was found that sound business principles can improve the result dramatically.

2.7 Quantitative methods for decision support

The standard, one-dimensional ABC-classification is a good way to do get a first rough overview, by using it in the traditional way, to see which parts that drive the most value. This analysis is however not ideal when there is more control characteristics then just value and volume. When classifying spare parts it is necessary to be able to take several additional characteristics in consideration (Huiskonen, 2001). The Analytic Hierarchy Process (AHP) is a method for helping making decisions with multiple criteria with the help of a mathematical model.

2.7.1 ABC-analysis

The ABC-analysis builds on the “Pareto Principle” that states that a large proportion of effects comes from small portion of the causes, ex that 80% of the sales comes from 20% of customers, this principle is also known as the 80/20 rule (Goetsch, 2013). The ABC-analysis is the Pareto Principle applied in an inventory management setting, dividing items in categories A, B or C (D, E), see Table 3 for an example of an ABC-division using value and items.

Table 3. An example of a typical distribution in A, B and C groups according to the Pareto Principle

Group	% of items	% of value
A	10	66,6
B	20	23,3
C	70	10,1

Table 3 shows how the groups in the ABC-analysis is having a distribution where A-items are the major source of the effects while being a small group in terms of number of causes, to the C-items having a small effect despite being numerous. A common way of presenting an ABC-analysis is by using a Cascading Pareto chart (Figure 1).

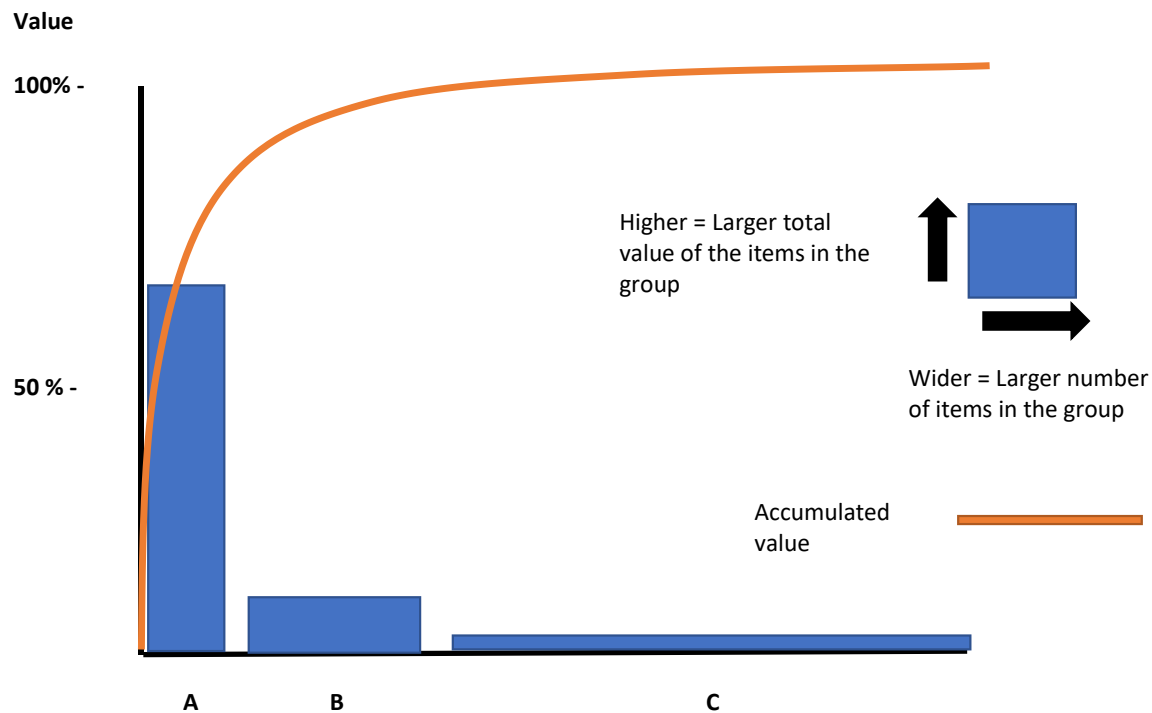


Figure 1. An example of a Cascading Pareto Chart.

The height of a bar in Figure 1 shows the impact of the group and a wide bar means a larger number of items. The orange line shows the aggregated value of the group and all the groups to the left of it.

The ABC-classification is the most common classification method in logistics, it is easy to use and serves its purpose of giving an overview of what items or categories that drives costs. It is especially when analyzing items where the only real differences between the entries are price (value) and volume (Huiskonen, 2001).

2.7.2 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process is a structured technique for analyzing decisions. It is used when multiple factors must be taken into account, finding the best solution based on those factors. Hence the process does not give an objective truth but depends on the importance of the factors relative to each other, their hierarchy. The widest application for AHP is in multicriteria decision making (MCDM) (Whitaker, 2007). In MCDM the ingoing factors are the importance of each of the factors to the decision maker. The options are then compared and a high performance on an important factor will then make that option rank higher than an option with high performance on a less important factor (Mu, 2016).

The AHP consists of the following steps (Mu, 2016):

1. Model the problem as a problem with a decision goal, and the criteria used for finding the solution.
2. Establish the priorities among the criteria used for the decision.
3. Synthesize (combine) the value of the criteria for each element with the priority of that criteria to create an overall judgment.
4. Check the constancy of the judgments.
5. Come to a final decision based on this process.

2.8 Most important themes in the theory chapter

The most important themes of the theory chapter, that will be used to structure the metalogical approach and as a framework to relate to in the discussion chapter are the following:

1. The purpose and effect of outsourcing and inventory management.
2. What kind of items and characteristics are suitable for outsourcing? With the four criteria presented by Huiskonen (2001) as a framework: Criticality, Specificity, demand pattern and value.
3. What is important in the collaboration between a 3PLP and a company?
4. The quantitative methods for categorizing and finding suitable items for outsourcing.

3 Method

This chapter describes and motivates the approach used for finding answers to the study's aim and research questions.

3.1 The principal approach

To answer the research questions the approach taken is a case study in which both quantitative and qualitative methods are used. The overarching approach is described more closely below.

3.1.1 Case study

A case study is a study where a phenomenon is studied in a real-world context (Yin, 2014).

Yin (2014) describes three situations when a case study is the preferred method:

1. The main research questions are “how or “why” questions.
2. The researcher has little or no control over the phenomenon.
3. The focus of the study is a contemporary phenomenon (as opposed to entirely historical).

This study follows and tries to understand the process of implementing an outsourcing solution (3) and seeks to answer what the motives are and how to implement it in a good way (1). The study is mainly observational, following the process (2). Hence a case study is a suitable method for this study.

3.1.2 Selection of the unit of analysis (case)

The unit of analysis is the sourcing and inventory management of spare parts at Essity's paper mill Edet in Lilla Edet. Essity is a major producer of paper and hygiene products. Edet, the mill where the study is conducted, is a paper mill which does not differ in any decisive way from a typical paper mill and is therefore suitable for answering questions related to papermills in general and also to a degree to the other forest-based processing industry in general, which all refines a material into a new in a large scale. Edet management have identified outsourcing of the inventory management as a possible improvement and are interested in investigating the possibilities. They are also able to provide data needed for doing a quantitative analysis of the current sourcing process.

3.1.3 A mixed-method approach

An interview and a participating observation of a meeting is used to understand how to analyze and interpret quantitative data and how to form a quantitative model. This approach to the study is a mix of both qualitative and quantitative methods, what Bryman & Bell (2013) calls “mixed methods research”. Qualitative data will be gathered to understand how to analyze the quantitative data and draw conclusions from it. Figure 2 shows “Morgan's classification of mixed method research” (Bryman & Bell, 2013, p. 633).

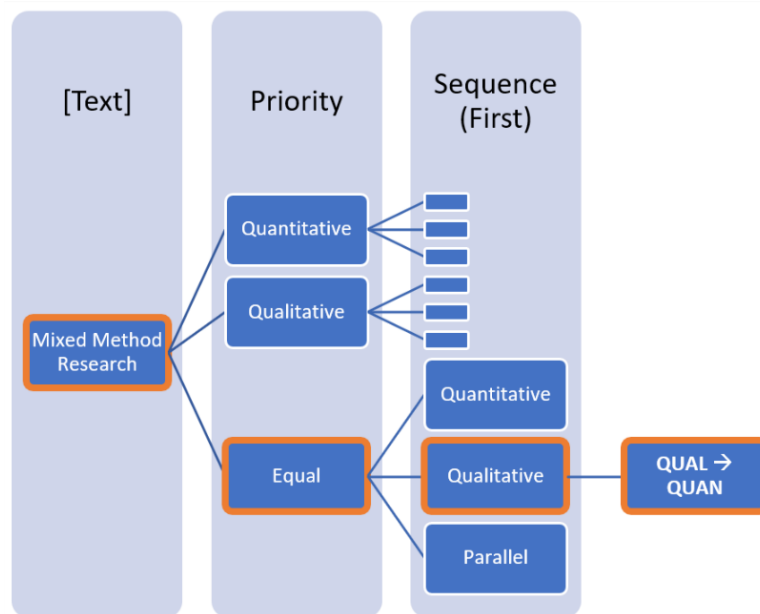


Figure 2. Classification of mixed-method research based on Morgan's classification of mixed method research, the illustration is based on Bryman & Bell (2013, p. 633).

The method used in this study is in the order of qualitative → quantitative with equal weight on both, putting this study in the **QUAL → QUAN** category in Morgan's classification as indicated by the orange highlighting in Figure 2. The Mixed-method approach is the natural choice since knowledge about how the quantitative data should be analyzed have to be gathered before applying the quantitative methods.

3.1.4 An inductive approach with a flexible design

Robson (2002) prefers to not classify research methods by quantitative and qualitative, favoring fixed and flexible designs. This study is flexible, that is a design that evolves during the data collection and the research design is not pre-specified with is the case when using a fixed design. This allows for knowledge gained during the data collection to be used to further evolve the research design. This is especially useful when studying a phenomenon that is relatively unknown to the researcher.

An inductive approach is where the consequences of the studies are then applied on the existing theory (Bryman & Bell, 2013). The inductive approach does not demand a hypothesis, this is in opposite to a deductive approach that formulates hypothesis from the theory which then is tested. The inductive approach has no formulated ideas on what the probable result is. This case study is using an inductive approach as it is studying something specific (a phenomenon at one company) and applies that onto the theory.

3.2 Data collection

The data needed to answer the research questions can be divided in two categories; Data that is quantitative and objective and data that is qualitative and subjective. Quantitative sourcing data is needed to describe the current state of the sourcing and is necessary for the AHP-model. Qualitative data is needed to understand the motives and goals of the outsourcing and what soft values are important.

3.2.1 Qualitative data

Qualitative data is non-numeric data (Robson, 2002) that is gathered through a qualitative method where the emphasis is put on words rather than numbers (Bryman & Bell, 2013). The qualitative data in this study was gathered by the way on interviews and observations. Knowledge about the relevant topics for the interview and observation was gathered through the literature review and information that needed to be gathered was identified. Table 4 shows which topics information was gathered about and through which method. Table 5 presents the participants and dates of qualitative data collection.

Table 4. Topics covered by qualitative methods

Information (topic)	Method used for gathering information
Motive	Interview with sourcing manager
Today's sourcing process	Interview with sourcing manager
Characteristic of suitable items	Interview with sourcing manager, Observation of meeting with a 3PLP
Implementation and Operation	Interview with sourcing manager, Observation of meeting with a 3PLP
Communication and cooperation	Interview with sourcing manager, Observation of meeting with a 3PLP

Table 5. Participants in interview and participating observation

Method	Participants	Title	Date	Transcription finished and sent for validation
Interview	Mikael Ståhl	Sourcing manager, Edet	28-02-19	08-03-19
Participating observation	Mikael Ståhl, N.N-1 N.N-2	Sourcing manager, Edet Sales manager, Unnamed 3PLP Industrial salesperson, Unnamed 3PLP	01-03-19	08-03-19

The understating of the current sourcing process and the motive for exploring outsourcing is gathered through the interview with the sourcing manager, the other topics were touched upon on by both methods (Table 4).

3.2.1.1 Interviews

The most common method for gathering data in a case study is interviews (Bryman & Bell, 2013). Compared to for example a survey an interview enables the researcher to be much more flexible and reactive to the respondents answers (Yin, 2014).

Yin (2014) recommends semi-structured interviews when the researcher have a quite good idea of which topics are relevant (knowledge gained through the literature review), but the answers is not necessarily predictable.

Based on the topics in Table 4 an interview guide was formulated (Appendix I). The interview was semi-structured and followed a rough interview guide to make sure the relevant topics and questions were touched upon, but the questions were still open ended. A strict interview guide

was not necessary as no statistical analysis was needed on this data or any comparisons between different respondents.

The Sourcing manager on Edet was able to provide answers on most topics in Table 5 and was together with the participating observation able to provide enough data to make it sufficient as the sole interview. The choice of interviewee was based on who I knew would be able to provide answers to my questions.

3.2.1.2 Participating observation

Operational methods have in common that they are observing the studied phenomenon itself in the real world. A participating observation compared to a direct observation allows for the researcher to be more than just a bystander (Yin, 2014). A benefit of the observation method is that it is very direct, the researcher does not have to ask the participants questions but can instead observe their behavior and dialogue without the researchers' external input. The observer can however, although it seems against the notion of an observation, ask questions about the situation and accounts given, to clarify and specify the data (Robson, 2002).

Since cases studies takes place in the real-world setting of the studied phenomenon there exists opportunities for direct observations. Anything from factory work to meeting can be observed (Yin, 2014).

The participating observation used in this study was conducted in form of a meeting with a potential 3PLP and the sourcing manager. The goal of the meeting was to gain information of what service the 3PLP could offer and that the interest of both parties was aligned. For example, the type of items relevant for outsourcing and the structure for a potential outsourcing solution was discussed but more meetings will have to follow between Edet and the 3PLP to investigate the specifics and come to an agreement. Table 5 shows what topics where touched upon in the meetings, either the conversation reached these topics naturally or with the help of clarifying questions.

3.2.2 Quantitative data

The company provided sourcing data that stretches a year back. The data is organized by received orders with the following relevant information about respective order (Table 6).

Table 6. Relevant information associated with the orders in the sourcing data

Information about every order	Description
Date received	Which month, not exact date
Spending Stream (level 1)	The broadest category, for example if its fiber to the main production or an item related to MRO activates
Spending Stream (level 2)	Sub-categories of the spending streams, still relatively broad
Material Group	Relatively specific, example of groups is: Bearings, Electrical engines, Tools and utensils.
Vendor	The supplier of the order
Value	The value of the order (EUR)
Exact item (with article-number)	This information is not complete and exists on less than 50% of items in most Material Groups

In total 7 data point about every order were relevant to the study (Table 6). The information of the exact item ordered is not comprehensive enough for an analysis on an item level as many items has this information as “not assigned”. The data was sufficient for an analysis on a material group level.

3.2.3 *Miscellaneous Information*

In addition to the participating observation and the formal interview, informal communication with Edet management was used to gather information about the production and sourcing process in. A tour of the plant is conducted to get further understanding for the production process the source of the underlying demand of spare parts. This tour also included a tour of the storage room used for spare part to understand the operative spare part management better. Finally, internal documentation and public internet sources was used to provide background information on Edet and Essity.

3.3 Quantitative methods for analysis

To analyze the material groups used by Edet and their suitability for outsourcing quantitative methods need to be applied. Doing the analysis qualitative and manually for one material group at a time would be to inconsistent and time consuming. By using a quantitative method that can be an applied through Excel it is possible to evaluate every material group and identify suitable material groups that will be considered further.

After an initial overview of the characteristics of spare parts compared to all sourced materials on Edet an ABC-analysis is conducted on the relevant material groups. ABC is an established way of creating an overview and understanding of what items or material groups are the most important in an inventory management context. Huiskonen (2001) recommends ABC as a way of analyzing the inventory but also emphasizes that the ABC-analysis is not enough when analyzing spare parts since they are less homogenous and more criteria have to be taken into account when making a decision.

To create a material for decision support AHP is used as this is a more advanced method that can compile multiple criteria into a combined result. AHP is most commonly used in MCDM which perfectly suits this study, one of its objectives is to find the most suitable items for outsourcings based on multiple criteria.

3.3.1 *Initial overview of spending streams*

The characteristic of MRO (Maintenance, Repairs, Operations) sourcing in general and spare part sourcing in particular is analyzed to confirm the companies suggested area of outsourcing (spare parts) as the most relevant one and to understand how this spending stream differs compared to Edet’s other spending streams. This is done by creating an overview of total value and total number of orders and compare the different spending streams using Excel.

3.3.2 *ABC-analysis*

To create an overview of the material groups (a group of similar materials or items) within the “engineering storeroom” spending stream an ABC-analysis is applied, the material groups are divided in A, B and C groups and pareto charts are created. The ABC-analysis is made by plotting the relations below in a Pareto Chart using Excel’s built-in Pareto Chart function (Table 7). The cut-of points for A, B and C groups are made using Excels Pivot-table function and sorting the causes by contribution to the effect and creating a running total of the contribution.

Table 7. Relations used in the ABC-analysis for plotting the Pareto charts

Effect (Y-axis)	Cause (X-axis)
Value	Material Group
Number of orders	Material Group
Value	Vendor
Number of Orders	Vendor

The effect and causes in the ABC-analysis (Table 7) is similar to the criteria used in the AHP-model below (Table 8) but creates a much simpler graphic overview.

3.3.3 AHP-model

After the ABC-analysis the dataset is prepared for the AHP-analysis. This is done by removing outliers, calculating the criteria used in the model and by normalizing these criteria. Then the hierarchy among the criteria is decided and finally the AHP-model is applied to calculate scores for the material groups indicating how suitable they are for outsourcing. The process is following the general structure of the AHP presented in the theory chapter.

3.3.3.1 Outliers

To create a more homogenous data set Material groups with a yearly Value (not including handling cost, just what is payed to the supplier) bellow 5 000 EUR is removed from the data. Keeping these outliers would result in the low value (and less interesting) material groups effecting and twisting the outcome of the more relevant material groups.

3.3.3.2 Deciding the criteria

The criteria used in the AHP- model is presented and motivated in Table 8.

Table 8. The criteria used in the AHP-model

Criterion	Short	Calculation	Comments
Average Value/Order	V_m	$-1 * (\frac{tV_m}{nO_m})$	Inverted, a low value/order will contribute towards a higher score. The total handling cost dependent to the number of orders. Items with low value/order will have a proportionally higher handling cost. This is the most important criterion for talking advantage of a the more streamlined sourcing proces of a 3PLP. Generic items typicly have a lower value.
Number of Vendors in relation to number of Orders	VE_m	$\frac{nVE_m}{nO_m}$	A high number of vendors compared to the number of orders show that there is potential to recrease the total number of suppliers and efectivize the sourcing process.
Number of Orders	O_m	nO_m	The more orders a material group have the larger the potential for aggregation effects is. Effects of consolidating orders and transportation. A high frequency of orders also indicates a material group with more generic or standard items that is desirable for a 3PLP.

The most important criterion presented in Table 8 is “Average Value/Order” as it indicates a proportional high handling cost and generic items.

3.3.3.3 Normalizing the data

To be able to use the AHP-model the data needs to be normalized on a scale from 0 (worst) to 1 (best) (equation 1). This is so the criteria's impact is independent of their respective absolute value.

$$N(X_m) = \frac{X_m - X_{min}}{X_{max} - X_{min}} \quad (1)$$

X_m = Criteria X for Material Group m

3.3.3.4 The AHP-Model (Synthesizing the judgments)

The concrete model used for calculating the score for each material group using Excel is as follows (equation 2)

$$S_m = 100 * [N(V_m) * W_v + N(VE_m) * W_{ve} + N(O_m) * W_o] \quad (2)$$

S_m = Score for Material group m

W_x = Weight for criteria x

This creates possible "AHP-Scores" in the range of 0-100.

3.3.3.5 Deciding weights (Establish priorities)

The hierarchy among the criteria is decided based on existing literature and interviews and observations conducted as part of the study. Hence there is no objective data behind the exact weights used in the AHP-analysis, they are rather selected based on what is concluded in the qualitative part of the study. The weights are then subject to a sensitivity analysis to investigate the effects of changing the weights and ensure the model robustness.

It does exist more complex ways to deciding the exact hierarchy among the factors and their weights, namely by using pairwise comparisons. This was however not deemed to give enough of an improvement to the weights that justified the more complicated and time-consuming process

3.3.3.6 Sensitivity analysis (Check the consistency)

The robustness of the model is tested by changing the weights used in the AHP-model and analyzing the effects on how the material groups rank in terms of score. Since what is important is the material groups score in comparison with each other and not the absolute score, the material groups rankings with different weights is used for evaluating the effects.

3.3.3.7 Making a final decision

After the model gives a score the result and the sensitivity analysis is conducted the result will be discussed and top-scoring material groups investigated to make a final decision (This is part of the discussion chapter).

3.3.4 *Ethical aspects*

In qualitative research there is often no clear rules for what is right and wrong but it is important that the research have a good morale approach to participants and society (Olsson & Sörensen, 2011). The gathered data should be reflected correctly and as completely as possible and not be used for making any dishonest conclusions (Bryman & Bell, 2013).

Bryman & Bell (2013) presents several ethical principles for research, the most important for this study is presented below:

1. No false pretenses – The researcher is clear with what the purpose of the study is and what information is being gathered
2. Informed consent – The participation in the study is voluntary and the participants are informed about their participation
3. Confidentiality – The collected data should be treated with the most confidentiality possible and no unauthorized person should have access to the data
4. Usage of data – The collected data should only be used in the scope of the study

These principles was used when collecting the data and conducting the study. Due to confidentiality the data will not be presented in terms of absolute numbers and values but rather as percentages, this is sufficient for describing relations among different data points. The absolute values would not contribute significantly towards understanding the phenomenon anyways. The 3PLP participating in the study will not be disclosed either due to confidentiality.

The interview was recorded and later transcribed and notes where taken continuously during the meeting with the 3PLP, these notes where than summarized. The transcription and summery respectively were sent to the participants for validation to avoid possible misunderstandings. A GDPR-form to be signed was also sent along to confirm the consent. The GDPR-form will be archived together with the summary and transcription centrally at SLU according to GRPR-regulations.

4 Empirical findings

This chapter presents the study's findings relevant to the research questions and provides a material for discussion in the next chapter. It begins with background empirics and continues with the findings of the qualitative research and follows up with the results of the quantitative methods.

4.1 Background empirics

Essity is a global hygiene and health company with sales in approximately 150 countries. The company employs 47 000 people worldwide and has annual net sales of 11.6 bn EUR. Essity was previously one with the company SCA and were officially listed as its own company in 2017. Essity is the Hygiene part of old SCA and produces products closer to the end-consumer while new SCA kept the Forest, Timber and Pulp and Paper industries.

Edet is a paper mill north of Gothenburg with about 400 employees and a yearly production of about 100 000 Metric tons. The mill produces within two segments; Consumer Tissue (ex. toilet paper under the Edet brand) and Professional Hygiene (complete hygiene solutions for companies, under the brand Tork).

The mill does not have any pulp production of their own, the fiber demand is filled primarily by recycled paper (86%) and the remaining 14% is bought as virgin fiber from pulp producers.

When everything works as it should the production runs around the clock, 365 days a year. The mill has one paper machine and two converting lines that create the final products. It is the maintenance of these production lines that are the source of the demand for spare parts.

4.2 The current sourcing and ordering process

Figure 3 shows how the sourcing process of spare parts works today.

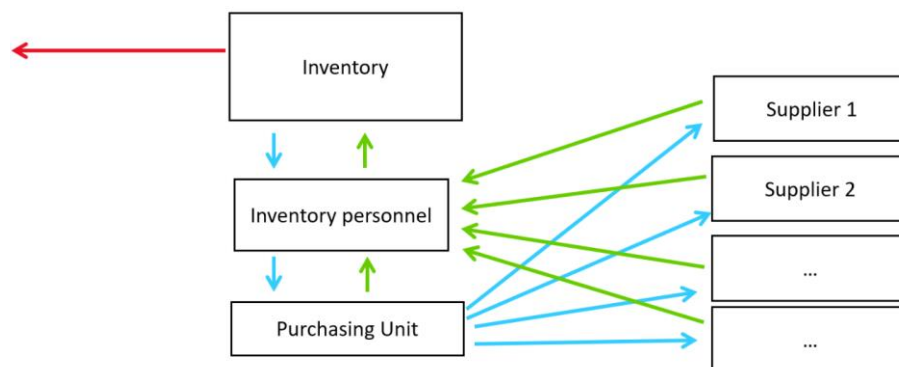


Figure 3. A schematic over the current sourcing process of spare parts.

The process in Figure 3 starts with an item being taken out of inventory to be used in maintaining the production (red arrow). The demand for spare has its roots in three types of maintenance:

1. Scheduled maintenance – maintenance during a larger and planned production stops with overhaul as a purpose
2. Preventive maintenance – maintenance that can be done without stopping the production completely and is done before the item fails

3. Reactive maintenance – when something breaks or fails. This type of maintenance is common and therefore spares must always be available, at least for critical parts.

When the stock of an item reaches the ROP (re-order point) the ERP-system (Enterprise Resource Planning) creates a requisition and signals (blue arrow) to the inventory personnel that an item needs to be re-ordered. This ROP check is done on a nightly basis. The personnel then confirm the requisition and the purchasing unit can then put an order to the supplier of that item. The item is then delivered and handled by the inventory personnel that places it in storage and register the delivery in the ERP-system (green arrows).

The four identified cost drivers in Edet's sourcing process are presented in Table 9.

*Table 9. Identified cost drivers related to the sourcing process *Transportation/Logistics is not from the perspective of the company but rather from the perspective of the whole supply chain*

Cost driver	Comment
Cost of capital	Directly dependent of total value of the inventory
Material cost	The value/ purchase price of the items
Physical handling	Receiving the orders, unpacking and placing in storage. Transportation/Logistics*
Administrative handling	Sending orders, handling invoices and communication with the suppliers

The cost drivers in Table 9 are the same as established in the theory chapter, there is nothing that stands out as special in Edet's sourcing process.

4.3 Motive

The reasons stated by the sourcing manager for wanting to explore outsourcing as a solution for spare part inventory management is presented bellow in Table 10.

Table 10. Motives for outsourcing

Motives	How important?
Economic	The main reason
Improving the quality of sourcing	Not a reason
Strategic	An implicit reason

The major motive behind outsourcing is economic, to cut costs in the sourcing process, this is the only explicitly stated motive when the sourcing manager is asked directly which the motives behind are (Table 10).

Although not stated explicitly as a reason for outsourcing, the strategic focus is of importance. The sourcing manager emphasizes that it is important to work toward making sure that all the activities on Edet creates value. An example given is when inventory personal unpacks and places an item on a shelf in storage; this step does not add any value to the item and is a process that could be shed.

It does not exist any specific measuring or evaluation methods of the existing spare part sourcing, the sourcing manager can however not see that the spare part sourcing is not a limiting factor in the production today. Hence the service level does not need to improve but rather stay the same while decreasing the costs. Relations with current suppliers is good and not a reason for outsourcing.

4.4 Implementation

By a participating observation of the initial meeting between Edet and a potential 3PLP the extent of how integrated the 3PLP should be and how the outsourcing solution should be implemented are identified. **Fel! Hittar inte referenskölla.** summarizes the desired relation between a 3PLP and Edet.

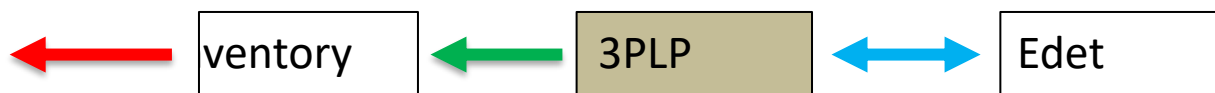


Figure 4. The desired implementation of outsourcing, the 3PLP's daily operations should be a black box from the perspective of Edet. Red arrow = demand on items in inventory, green arrow = re-stocking by 3PLP, Blue arrow = communication between Edet and the 3PLP.

Figure 4 shows a solution where the desire is that a 3PLP is fully integrated and re-stocks items all the way to the shelves in the storage room. The employees of Edet should create value, unpacking and putting an item on a shelf does not create any additional value for that product. The 3PLP will also be responsible for all inventory control and management of the outsourced items. The goal is just that everything should be available when necessary, how that is accomplished is not of concern to Edet, the less they must focus on the sourcing of these items the better. They just want to get an invoice every month and everything should just work by itself and be more or less a black box from the perspective of Edet.

This should not be misinterpreted as communication being unimportant, transparency and communication are emphasized as something of importance. With quarterly or half-year follow ups where improvements are discussed and if more items should be incorporated in the outsourcing solution. Monthly operative follow up meetings ensuring everything works as it should and if there are any problems. The 3PLP should be transparent in how they are setting their prices and ensuring market price and updating the price to be in line with the market if prices are changing.

It is also desired that in the sourcing solution it is clear what parts of the inventory the 3PLP is responsible for, with their own trucks and marked shelves. In an optimal solution the 3PLP will handle the inventory control by themselves by keeping inventory and check when items reach the ROP. Hence they have no need for access to Edet's ERP. During the implementation process the 3PLP will need information about items and demand but after hand when they start to collect data themselves they can also manage their inventory control (for example deciding ROPs) based on their own data.

4.5 Collaboration with a 3PLP and continues improvement

Both parties emphasize that they want a long-term contribution, reaching over 10+ years. The collaboration will be tried out with maybe one or a few material groups and then potentially expanded when they have learned from experiences with the first material groups. When the 3PLP starts collecting their own data, they can start improving and streamlining their own

sourcing process, as well as coming up with suggestions for improving the collaboration further. Continuous improvement is important to Edet and that the 3PLP suggest improvements on how to expand the collaboration.

4.6 Characterizes of items suited for outsourcing

The characteristics of items that is target for outsourcing is summarized below in **Fel! Hittar inte referenskölla..** What is interesting from Edet's point of view and what the 3PLP is best at.

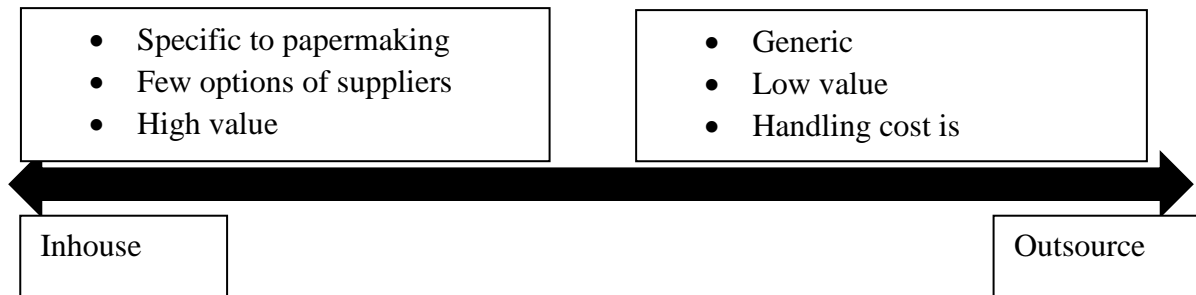


Figure 5. Summarization of what kind of items are suitable for outsourcing, based on an interview with the sourcing manager at Edet and participating observation of a meeting with a 3PLP.

The factors that favours outsourcing in Figure 5 is what the 3PLP calls “bread and butter” items, items that are generic, low value and multiple manufactures and vendors exists. An example of such non-specific items are bearings and shovels, items for which brand and retailers are interchangeable. This is also for this kind of items Edet believes they can garner the largest cost savings, for these relatively low value items where that handling cost often exceeds the value of item. Edet recognizes that often low value items take up an unproportionable big slice of the handling cost. According to the 3PLP 3% of the items can stand for up to 65% of the handling cost.

In short, the largest economic winnings are not necessarily reached by getting a lower price on the items themselves (even though this also is a desired effect of the outsourcing). But rather by decreasing the handling cost.

One additional group of items that was raised during the meeting with the 3PLP as interesting for outsourcing is items such as personal protective gear and clothing which is personal to the employees and ordered when needed.

4.7 Material groups that fits this description

The quantitative methods presented in the method chapter are used on the provided sourcing data together with the information gathered in the section above and existing literature to identify which of Edet's material groups are candidates for an outsourcing solution. This is done by creating a brief overview of all sourcing at Edet and applying the ABC-analysis and the AHP-model on the spare part material groups.

4.7.1 The spare parts spending stream in relation to all sourcing

Figure 6 summarizes how the categorization of what is sourced to Edet is structured.

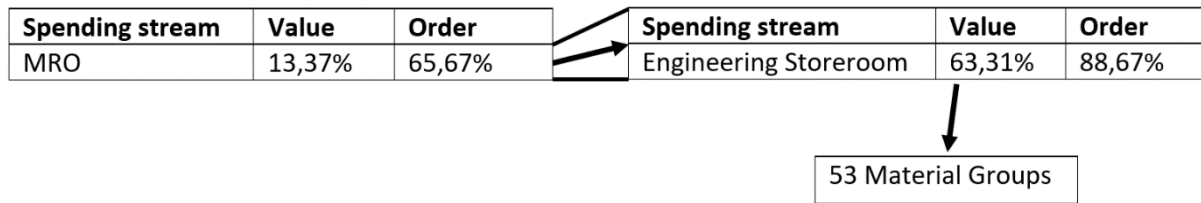


Figure 6. Schematic of how the sourcing data is organized.

As can be seen in Figure 6 MRO is a large spending stream on Edet, making up about 13% of Edet's sourcing costs. This is third only to the main input to the production, Recycled Fiber and Virgin Fiber. MRO however stands for 2/3 of the number of purchases (orders), and therefore have a high order to value ratio. This indicates that MRO are the mills economically most interesting area in regards of effectivizing the sourcing and handling process as it handles a high number of low-value items.

Of the spending streams within MRO a category called "Engineering Storeroom" is in focus, this is items that engineers, and maintenance have free access to, for usage whenever it is necessary. This category consists of items that generally is of low criticality and low specificity and is not exclusive to a single supplier. "Engineering Storeroom" makes up about 63% of the MRO sourcing cost but 89% of the orders. Indicating that they are more general, low-value items. This is also confirmed by management to probably be the most relevant spending stream and is what they refer to when talking about spare parts.

The items in the Engineering storeroom spending stream is then divided in 53 material groups. It is on these material groups the ABC and AHP analysis is applied.

Examples of MRO items *not* included in further analysis (not part of "Engineering Storeroom") are "Blades and Knives" and "Felts & Wires". These categories consist of items and materials that is specific to the paper machines and converting lines and are both critical and specific. There are therefore not interesting for outsourcing and not relevant for further analysis.

4.7.2 ABC-Analysis of the spare parts (Engineering storeroom)

The result of the ABC-Analysis are presented in the Pareto charts below together with a division in A,B,C (and D) groups (Figure 7-10). The charts bellow creates an overview of the spending stream, with the y-axis representing the effect and x-axis the cause.

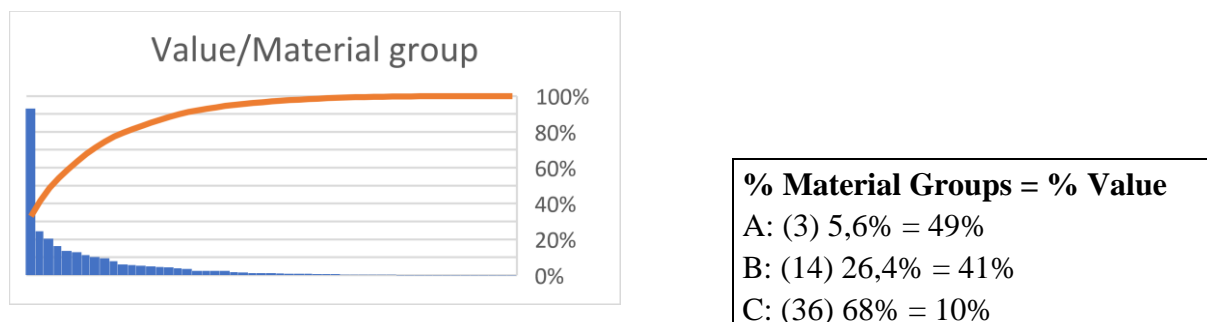
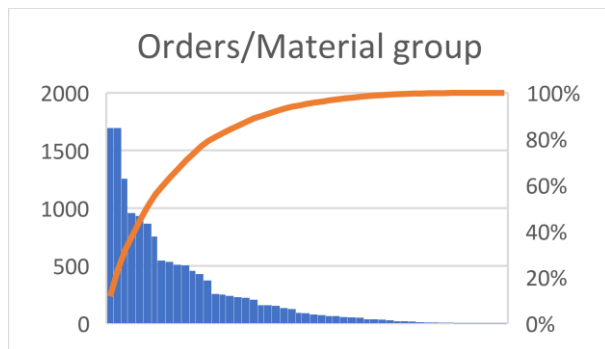


Figure 7. Pareto chart over Value and Material group.



% Material Groups = % Orders

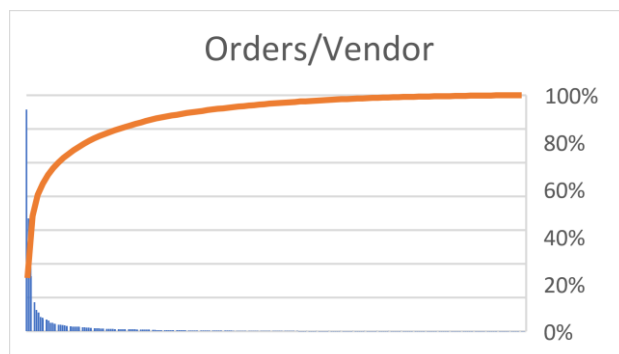
A: (5) 9,4% = 41%

B: (12) 28,3% = 40%

C: (36) 68% = 19%

Figure 8. Pareto chart over Orders and Material group.

In terms of value 3 categories makes up about 50% of the yearly value (Figure 7). This is line with the pareto principle, that a low percentage of sources makes up a large proportion of consequences. The distribution of orders (Figure 8) have a similar distribution overall but the top material groups are much more equal.



% Vendors = % Orders

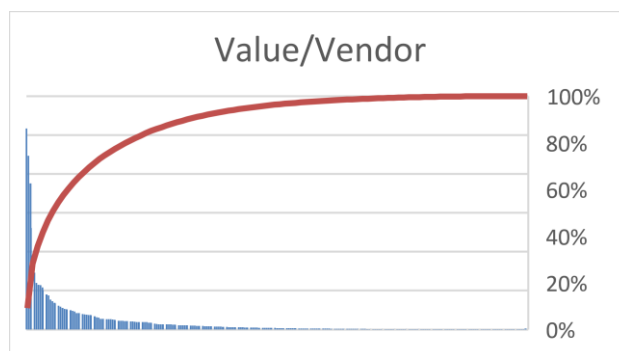
A: (7) 2,4% = 36%

B: (28) 9,6% = 30%

C: (80) 27,5% = 24%

D: (176) 60,5% = 10%

Figure 9. Pareto chart over Orders and Vendor.



% Vendor = % Value

A: (7) 2,4% = 36%

B: (23) 7,9% = 30%

C: (65) 22,3% = 24%

D: (197) 67,7% = 10%

Figure 10. Pareto chart over Value and Vendor.

When looking at orders and value per vendor (Figure 9 & 10), the top 7 vendors makes up 36% of both orders and the value, the majority of which are retailers of industrial components. The Pareto charts for both Order/Vendor and Value/Vendor have very long tails compared to the traditional pareto division with many small vendors (the D category). The D category makes up the majority of vendors but only 10% of the value and orders respectively. The vendors in the D category have all less than 7 orders yearly and delivers a yearly value of less than 11 000 EUR.

4.7.3 AHP

After Material groups with a sourcing cost below 5000 EUR/year were removed to avoid outliers 39 Material groups were left.

Based on what were found out in the discussions with the sourcing manager and 3PLP (Figure 5) together with existing theory the importance of categories was given the following weights (**Fel! Hittar inte referenskälla.11**):

Table 11. The weights used in the AHP-model

Criterion	Weight
Value/Order (W_v)	0,6
Number of orders (W_{ve})	0,25
Vendors/Orders (W_o)	0,15

The most importance in the model are given to Value/order. Table 12 shows the 16 material groups that got a score of 60 or higher when evaluating on the criteria in Table 11.

Table 12. The material groups with an AHP-Score over 60

Mat grp	Score
Tools, Utensils	72,6
Bearings	65,9
Pneumatic, Hydraulic	65,7
Steel Tubes	65,7
Spacers, Washers	65,7
Electrical Switches	65,0
Cleaners, Disinfect	65,0
Electrical Distrib.	64,3
Conduction, Insulat.	63,6
Hoses, Connectors	63,3
Semi-manuf Rubber	63,3
Protecting Elements	62,1
Drive Belts, Chains	62,0
Bulbs, Speakers	61,8
Welding, Soldering	61,4
Protect Cloth, Equip	60,9

The complete table of Table 12 can be found in Appendix II. A higher score indicates that a material group consists of “bread and butter” items and are the first to be considered for outsourcing.

“Tools, Utensils” have the highest score with a gap to the rest. Of the 16 material groups with a score over 60 the top 3 in terms of value are: “Drive Belts, Chains”, “Tools Utensils” and “Protective Clothing, equipment”.

Examples of low scoring material groups with items that should not be considered for outsourcing are “Pumps, Fans, Compressors” and “Electrical Motors”.

4.7.4 Sensitivity analysis

The robustness of the model is tested by changing the weights while keeping the same rank of importance ($\text{Value/Order} \geq \text{Num Orders} \geq \text{Vendors/Orders}$). The resulting ranks with the different weights are presented in Appendix III.

The sensitivity analysis shows that while there is some variation when the weights are shifted, they generally stay in the same end of the range.

4.8 Risks with outsourcing

The sourcing manager does not see any apparent with outsourcing, as long as the knowledge of specific items are kept inhouse.

One slight concern is the response of employees and that outsourcing often is associated with negative connotations, especially as it might lead to people losing their job. In this case this worry is somewhat mitigated by upcoming natural retirements.

The outsourcing solution have been tried with good results on a couple of other Essity sites with slightly different type of production, so the economic viability has been proven.

5 Discussion

In this chapter the results are discussed in the context of previous research and the most important takeaways are highlighted. The studies contribution and limitation is also discussed along with suggestions on further research.

5.1 Motives of outsourcing

The explicitly stated goal for the outsourcing is purely economic. This is not surprising since creating value for the shareholders is the objective for any publicly listed company. The way to reach this improved economic performance is believed to be mainly by way of decreasing the costs directly connected to the sourcing process (price of items and handling cost). An enhanced focus on core-competence and Edet's core-process is implicitly stated as a secondary reason for outsourcing. The importance of the employees creating value and that items specific to papermaking should be kept inhouse for the sake of keeping that knowledge indicates this. By shedding non-core activities remaining employees can focus more on value creating activities. Existing literature have also reached the conclusion that cutting costs and ability to focus on core-competence are the two most important motives for outsourcing (Chopra & Meindl, 2016).

5.2 Cost drivers and potential improvements with outsourcing

The interesting thing is how Edet aims to use outsourcing to reach its motives of decreasing costs and reaching a state where employees spends less time on non-value-creating activities. The identified cost drivers of Edet's sourcing process will here be discussed in the context of Chopra & Meindl's (2016) three ways that logistics outsourcing can be used to a benefit; Aggregation of demand, Specialization and Strategic focus.

Cost of capital (value of items in inventory)

The cost of capital is generally the most important factor to consider in inventory management and keeping a low level of total inventory is at the core of inventory management. By aggregating the demand of multiple companies the total level of inventory in the supply chain can be kept down which creates a larger supply chain surplus. By having a more efficient restocking and inventory control a 3PLP can potentially also decrease the level of inventory kept onsite at Edet and thus directly decrease Edet's cost of capital for the items.

Material cost (value of the purchased items)

By aggregating the purchases from multiple industries and buy items from vendors in larger quantities size rebates can be reached and keeping the price down by negotiating for multiple customers. After a small mark up from the 3PLP the material cost for Edet should at least be the same but probably lower. This way of cutting cost is established through the observational meeting with the 3PLP and is also recognized by.

Physical and administrative handling

The existing literature lifts that by aggregating the demand from multiple sites a 3PLP can create a more efficient logistics network than the Vendors and a single company can by themselves, primarily by keeping a lower level of total inventory.

Both Edet and the 3PLP sees the handling as where the big savings can be made, the 3PLP sees their expertise as items which are of low value and where the handling cost is a large proportion of the items total sourcing cost. The reasons for this being possible is the effects of

specialization and the 3PLP having the sourcing process as its core competence is another reason that the 3PLP can have a more efficient handling of the spare parts inventory. The 3PLP have a more streamlined process for this and are specialized in this area. The 3PLs focus can also justify them keeping and updating cutting edge systems and equipment, this is something a company not having inventory management as a core competence can do (Parashkevova, 2007). To exemplify the (in comparison to the handling cost) small effect of lowering the material cost for “bread and butter items” the spare part sourcing can be compared to Edet’s overall main sourcing cost; The sourcing of fiber, for which a small percentage cost decrease (material cost) would equal a much larger cost savings than more than on the low-value “bread and butter” items.

This more efficient sourcing process can cut cost by requiring less inventory personal employed by Edet and less time spent putting orders to the suppliers. Shedding non-core activities and letting a third part do this while focus on value-creating activities is very core to the whole concept of outsourcing (Quélin & Duhamel, 2003).

5.3 Items suitable for outsourcing

The four spare part characteristics presented by Huiskonen is used as a framework when discussing item suitable for outsourcing.

Criticality

The criticality of the items does not seem to be a deciding factor when making the decision of outsourcing. There is no reason that a 3PLP cannot handle this as good as the company itself can. In practice however, critical parts may be kept inhouse to a larger degree than non-critical since the criticality often correlates with the specificity.

Specificity

This study finds that specificity works as a disqualifying criterion when considering outsourcing of an item. This is because the knowledge specific to the company’s core-competence is desired to be held inhouse. Outsourcing items related to the company’s core-competences would counteract the core idea out outsourcing, to be able to focus on the company’s core-competences (Quélin & Duhamel, 2003).

The non-specific items are also more attractive to a 3PLP. Huiskonen (2001) explains this with the better opportunity for aggregation of non-specific items used by many of the 3PLs customers.

Demand Pattern

The data for this study was not specific enough (on monthly basis, some missing data on material level) to analyze the variations in demand. The existing theory does however suggest that there are larger winnings in aggregating the demand of items with an unpredictable demand (Chopra & Meindl, 2016).

This study however finds that “bread and butter” items, items that are ordered frequently but also generic and of low value are the most interesting for outsourcing. This is most likely due to the correlation between low value products and a smooth demand pattern. This study can however not conclude anything about the demand pattern in a vacuum. The effects of an uncertain demand pattern must be studied more to be able to make any conclusions about its impact on the suitability of outsourcing.

Value

The value is together with the specificity the most important characteristic of a “bread and butter” item. While the specificity is hard to grade and works more like a disqualifying criteria than on a scale. The value of the item, or rather the value of the average order on the other hand is very easy to grade on a scale. This is also way this factor has the impact on the model. The reasons are that the low value/order items have a higher ratio of Handling cost/Value, since the handling cost correlated to the number of orders rather than the total value of orders. It is for these items an effectivization and streamlining of the handling have the largest advantage.

This is the same findings as Huiskonen (2001) and Quélin & Duhamel (2003) have found, that economics of scale allowed by aggregation of purchasing and transportation are most prevalent for items with a large number of low-value transactions. When it comes to the more efficient handling Huiskonen (2001) specifically lifts the administrative cost associated with every order. In this case that would be the steps between realizing the need to re-order and placing the order, as well as the registration of arriving orders,

5.4 Personal items and clothing

A group of items that differs from the others and not covered by existing theory but Edet shows a desire to have included in the outsourcing solution is items that are personal to the employees. Items not shared and can differ from employee to employee, primarily shoes and other clothing. The big difference for these items is that they cannot be included in the 3PLP’s inventory control, they have to be ordered when needed. By creating an online catalog of such items that the 3PLP can include those items in their standard delivery cycle. This allows for continuous ordering instead of having certain occasions during the year all such items are ordered. The consolidation also allows for a better overview and cost control the items by having a single supplier.

5.5 Collaboration and implementation

Historically many outsourcing solutions fails or do not reach their full potential (Hill, 2000). The paragraphs bellow explains the way an outsourcing relationship can be organized to avoid potential problems within the collaboration with the 3PLP.

5.5.1 Full integration – VMI

It is important for Edet that the 3PLP is fully integrated in terms of handling the whole process from inventory control to physical re-stocking. The 3PLP should however work independently of Edet in the daily operation with their own delivery trucks and shelves in the storage room and more or less be a “black box” form the perspective of Edet. This is very similar to the way VMI works, with the supplier of the items being responsible for the inventory. VMI is most commonly explained in the context of a supplier handling their inventory at a retailer with the end consumer driving demand. In this study the end consumer is substituted for the production and the inventory is the storage for spare parts. Existing theories of VMI concludes that its best suited for low cost, nonspecific items with a high to medium consumption rate (Bailey & Helms, 2007; Cavalieri et al., 2008). This further strengthens the argument that Edet should focus on these kind of items. The clear distinction of what the 3PLP is responsible for and what is kept under Edet’s inventory control should also help alleviate potential conflicts and uncertainties between the Edet’s inventory personal and the 3PLPs personal.

5.5.2 IT problems

The problem of having compatible systems is an according to existing research a potential problem (Schwyn, 1999), and also a problem Essity have had on other sites that outsourced more than just the spare part inventory. This is however not an important barrier for the implementation in this case study, the 3PLP will keep an inventory control of their own and does not require access to data from Edet's ERP after the initial setup where they need information about the demand. The potentials problems from incompatible data systems is then avoided.

5.5.3 Other important factors in the outsourcing relationship

Three factors are particularly important to Edet in the relationship with a 3PL, the relationship should be: Long term, evolving (continuous improvements, expanding to additional material groups) and transparent. It is clear that these are important factors and good communication is key since they are also emphasized in existing literature, Hill (2000) for example concludes that 70% of failing outsourcing relationships fails as the result of poor communication. By having an evolving relationship the collaboration can to a beginning use just a few material groups. Under this period the viability of the outsourcing is tested and the collaboration is fine-tuned while on this smaller scale. Once both parties than are satisfied the outsourcing can be extended to more material groups. By doing it this way large cost created by attempting to fix problems once fully outsourced can be avoided.

5.6 Suggestions for KPIs

It does not currently exist any KPIs for evaluating the current sourcing process, this also means that there are no explicit KPIs that can be used to compare the current sourcing process and the result of working with a 3PL. The evaluation that can be done is on a macro level and comparing the cost of the whole sourcing process. This can give an indication but does not necessarily fulfill the criteria of a good KPI, being clear and actionable (Wolf, 2010). There is however an opportunity to instate KPIs that can measure the future performance of the 3PLP and how it develops.

The quality of the outsourcing have two components that are measurable, the cost and the service level. The proposed KPIs are presented in Table 12.

Table 12. Suggestion for KPIs for evaluating the outsourcing solution

KPI	Type of KPI	Comment
Material cost	Cost	Directly reflects the 3PLs ability to get a lower purchasing price on the items. Can be compared in relation to an index reflecting the market price.
Stockouts	Quality	In terms of the production running smoothly this is what matters, indicated if the existing high service level today is kept with the outsourcing solution.
Deliveries outside of routine	Quality/cost	Ex. if express deliveries are required to avoid stockouts, indicated that a stockout can be close and incurs an extra cost.
Time spent on the 3PLP relation	Cost	To reflect the administrative burden on Edet. A more concrete indicator would “number of invoices” or “Orders put by Edet” to see how this changes for material groups where outsourcing is used. “Time spent on the 3PLP relation” indicates in a better way the administrative burden after the outsourcing is implemented. This KPI might be difficult to implemented in practice since it might be hard to find a concrete measurement.
Total inventory value	Cost	Reflects the cost of capital of the items in inventory, indicates if the 3PLP is able to decrease this cost.

If possible it is recommended to start gathering data for the KPIs in Table 12 with the current state of affairs, before the outsourcing, to be able to compare if it is successful or not, especially for those that does not require any large effort like sourcing cost and the number of invoices handled today for the considered material groups. Some of the other would require more work, one that is not included in the suggested KPIs are the handling cost, to find a KPI for this would need a time study of inventory personal and the unloading process to be able to allocate the correct cost to the correct process. If this was done it would be possible to evaluate cost reductions in terms of the handling cost.

The usage of KPI requires that the 3PLP shares necessary data that is needed for creating the KPIs, emphasizing the advantages of information sharing and transparency.

The suggested KPIs are closely connected to the cost drivers, concrete and actionable, and they are not in direct conflict with each other just as (Wolf, 2010) recommends. The suggested KPIs are generally adaptations of already established KPIs for spare parts inventory management according to “spares inventory value improvement” (Lin & Ghodrati, 2011), giving the suggested KPIs further credibility.

5.7 Discussion of the quantitative analysis

By looking at the data, using Essity’s system for categorizing their spending streams it was clear that it was the “Engineering Storeroom” and its material groups that would be interesting for the analysis. It was in this spending stream a lot of the orders happened but with a unproportionable small sourcing cost. This was expected by Edet and the data confirmed that this was the right place to look for items to outsource.

The ABC-analysis shows clearly that it is a few material groups or vendors that drives both total cost and the number of orders. What is more interesting however is the very long tails, especially when dividing by vendor (the division among the material groups are closer to the usual examples used when explaining the “Pareto-effect”). This is the result of having a lot of

vendors with very few orders or value (61% of all vendors were only used for 6 or less orders /year and 68% of the vendors were used to a value of less than 11 000 EUR /year).

The AHP-model have suggested materials groups whose items have the characteristics that is requested, “bread and butter” items. One way this can be seen is when looking at the top vendors of the highest scoring material groups, they are mostly retailers of industrial components, indicating that the items within these material groups are generic and interchangeable. These retailers of industrial components do not necessarily have any specific knowledge about the products as it is not their brands. Therefore no knowledge gets lost if the relations with them are cut. The most specific items on the other hand are bought directly from the manufacturer.

Retailers of industrial components are companies that sells products that are used by multiple industries, they offers items from multiple manufacturers and does not have any manufacturing of their own. They do generally provide items that are generic and are interchangeable. They have the same roll as for example a clothing retailer that sells multiple brands, if you want more high-end and specific clothing you will go directly to the manufacturer but if you need a generic tee that multiple manufacturers produces a retailer is your best option.

The largest retailers of industrial components in Sweden are: Ahlsell, Tools (Momentum), Derome and Würth (Ahlsell, 2019).

The top scoring category by a margin, “Tools and Utensils”, is exactly the archetype of items that can be outsourced. Looking closer at the items within the group items are almost exclusively supplied by retailers of industrial components and the items are generally both of low value and non-specific. Examples of items are tools like knives, plies and wrenches. The utensils are for example sacs and trash bags. One perhaps surprising but still important utensil in this material group is coffee (which of course is crucial for any Swedish workplace). What the items in this material group have in common is that they are not directly used in the production, as parts in a production process. They are rather used to make the rest of the MRO process working; hence usage of any particular brand is not necessary.

The second material group in terms of score is “Bearings”. Since bearings are used directly in the production, they are a more critical to its process than “Tools and utensils” but otherwise the two material groups share a lot of characteristics. They are generally bought through a retailer of industrial components, are generic and there are multiple manufactures available. The “Bearings” material groups are homogenous and does only include different types of bearings.

Other than the top two in terms of score “Protective clothing and Equipment” and “Drive belts and chains” drives the most value of the material groups with a score over 60. “Protective gear and equipment” are exactly what is sound like and have pretty much exactly the same characteristics as “tools and utensils”. The lower score come of the orders generally being of higher value, one possible reason being that items to a larger degree is bought in bulk, for example gloves are never bought individually.

“Drive belts and Chains” are made up of ex Drive Belts. Chains for transportation and discs. Similarly, to Bearings they have a critical role but are not specific to the paper making industry, bearings allows for things in general to rotate and Drive belts drives things in general, by linking rotating shafts together and transferring power between them.

The lower scoring material groups have in common that they have a higher value and when looking within the material groups the items are more complicated and specific. Example of items within the lower scoring material groups with a high annual sourcing cost are different kinds of electrical motors and Pumps.

When looking into the individual material groups it seems like using this model with emphasis on value/order is a good way of finding what kind of items are suitable for outsourcing. The results show that this model produces results that are also in line with the criteria for keeping specific items, without having this criterion specifically in the model. This is very useful since classifying all items on how specific they are would be very time consuming and require knowledge of the items. Instead the specificity can be assumed to correlate with value/order and then just double check for items within the high-scoring material groups.

The sensitivity analysis shows that the model is quite robust, the rankings does not change much even when testing rather extreme scenarios. This together with the earlier evaluation of high/low scoring material groups gives the model and results a high reliability. The used model is in the middle of the other scenarios and shows the best ranking in terms of being in line with the desired criteria when investigating what the material groups contain.

Between the presence of retailers of industrial components and the examples of items in the high scoring material groups it can be concluded that the model successfully produces high scores for the material groups that are in line with what is desired, material groups with generic “bread and butter” items. This while producing low scores for material groups with items that are expensive, critical and specific to paper production and converting inhouse. All this is suggesting that the AHP-model is a viable method for finding categories most suitable for outsourcing and further investigation.

5.7.1 *The quantitative findings in the context of previous research*

The suitability of outsourcing for different categories as defined by previous research (Table 1) and examples of material groups that fits into these categories are presented below in Table 13.

Table 13. The outsourcing suitability of different categories of spare parts

Spare part category	Suitability for outsourcing	Example of material groups
Specific and Critical	Not suitable, better kept inhouse.	Electrical engines, Pumps
Generic Spare Parts	Suitable	Bearings, Tools
Consumables	Suitable	Driving belts, Filters, Lubricants

The criticality is not found in this study as being an important factor in what should be outsourced, the specificity on the other hand is the most important factor when making the decision. Generic spare parts like bearing can be critical but that does not disqualify them from the outsourcing possibilities.

Generic spare parts and consumables have in common that they are available from many suppliers and manufacturers as well as usage in multiple industries, this creates the opportunity aggregation in the supply chain through the usage of a 3PLP. Generic spare part and consumables also have a smoother demand, consumables as their exhaustion or end-of-life is

very predictable and generics by generally having a large demand that makes the unpredictability of individual items neglectable.

5.8 Generalization of the study and its limitations

This case study is conducted at Edet, one of Essity's Swedish paper mills. The mill does not have integrated pulp production but are instead using mainly recycled fiber as input to the production. The studied process of spare part sourcing is however not linked closely to the above description. The method and results can be applied on any industry that have a similar usage and sourcing of spare parts. Hence the study is relevant to any large-scale processing industry where spare part management is a large and important factor for keeping the production running. Especially the finding about that items suitable for outsourcing are today to a large degree delivered by retailers of industrial components suggest that the findings can be generalized since retailers of industrial components has as their business idea to deliver generic items to multiple industries.

With all this being said, caution must be taken when generalizing as the study has the limitations of a case study. It has single site as a sample, case studies should not be generalized to be true for whole populations (other sites or companies) but rather be seen as a contribution to the theory (Yin, 2014).

5.9 Comparisons with previous studies and this study's contribution

While there are no previous studies on the same exact subject, outsourcing of the spare part inventory management, there are findings corroborating finding in studies about either spare part management or outsourcing in general. Namely economics being the primary motive behind outsourcing (Kremic *et al.*, 2006) and VMI being best suited for low cost, nonspecific items with a high to medium consumption rate (Bailey & Helms, 2007; Cavalieri *et al.*, 2008)

This study contributes with knowledge in the specific topic of outsourcing in a spare part management context, in a processing industry. An otherwise unexplored area of research. The study identifies what kind of items that is suitable for outsourcing and presents a simple method for identifying those items. The study adds to previous research on outsourcing about the motives, where the potential savings are and important factors between a company and a 3PLP.

5.10 Validity of the study and suggestions for further research

The study have not used data to study the effects of the outsourcing but relies on the testimonies of the 3PLP and Edet management to identify what characteristics are the most suitable for outsourcing. This is however maybe the two best sources possible with exception for actual data since the 3PLP have experience of the outsourcing solution and knows from experience for which items it works the best and no one knows the sourcing process better than the sourcing manager on the mill. In a similar way the study does not follow the actual implementation process of outsourcing but rather reflect what is believed to be important.

A longitudinal study that follows the implementation of outsourcing and the resulting effects would therefore be interesting to get an evaluation of the outsourcing solution working in practice.

The study relies on a single dataset from one company and only a couple sources for qualitative data so similar case studies would be relevant to confirm or question the findings of this study and to what degree they are possible to generalize.

The study did not evaluate the criticality and specificity of the material groups and used that in the AHP-model, instead this was double checked for the material groups the AHP-model gave the highest score. A high score were found to correlate with a low specificity and to have no correlation with criticality. If a larger study were conducted it could evaluate these criteria and do a statistical analysis to find a quantifiable correlation and integrate this criteria in the AHP-model.

6 Conclusions

This chapter concludes the study's most important findings for fulfilling the aim of:

“identifying and describing the considerations that needs to be taken in the process of implementing an outsourcing solution for the spare part inventory management of a company in the pulp and paper industry, as well as presenting possible answers to those considerations“. The conclusions are presented below as concise answers to the research questions.

6.1 Motives for outsourcing

The major reason for wanting to use outsourcing is economic, to decrease the company's sourcing cost of spare parts. The ability to focus on the company's core competences and making sure that the company's employees are spending their time on value-creating activities.

6.2 Cost drivers and possible improvements

The four major costs that can be impacted by an outsourcing solution are: the material cost, the cost of capital and the cost of physical and administrative handling. Out of these the largest cost savings are expected on the handling cost, both the physical handling of the items and on administration. This is done by the 3PLPs ability to take advantage of aggregation and specialization by having inventory management and logistics as its core-competence.

6.3 The outsourcing relationship with a 3PLP

The desired outsourcing solution includes full integration of the 3PLP. The items that the 3PLP is responsible for should be delivered all the way into storage and placed on its designated place. Other than the physical re-stocking the 3PLP will also be responsible for the inventory control and monitoring the inventory levels. The outsourcing should work as a vendor managed inventory, where the 3PLPs inventory management is a black box from the perspective of the company.

Even though the 3PLP's operative process is not of interest to the company the relationship is important. The relationship should be long term, transparent and evolving with continuous improvements and an expanding collaboration.

To ensure the quality of the outsourcing it is suggested that Key Performance Indicators (KPI) are implemented to evaluate the outsourcing. Examples of suggested KPIs are stockouts, total value of the inventory and material cost.

6.4 Categories of items a suitable for outsourcing

The items suitable for outsourcing are the “bread and butter” items, items of low value that is ordered frequently and for which the cost for handling is unproportionally to the value of the item. Generic items with a low value are the primary target for outsourcing. Items specific to the paper making business on the other hand are disqualified from an outsourcing solution as it is important for the company to keep the knowledge of such items in-house.

A common theme among the items suitable for outsourcing is that they today are supplied by retailers of industrial components and are used in multiple industries and not just in the pulp and paper industry.

The result given by the AHP-model used in this study have “Tools and utensils” as the material group most suited for outsourcing. This material group includes items such as knives, wrenches and sacs. Other material groups with a high score are for example bearings and washers. All these material groups have in common that they include generic, low value items that are used in multiple industries. Examples of material groups not suited for outsourcing is according to the AHP-model electrical engine and pumps.

One special kind of items to be included in an outsourcing solution are items personal to individual employees, such as shoes and other clothing. These are items that are ordered when needed rather than always being kept in inventory. By having an online catalog at the 3PLP the employees will be able to order these items by themselves and continuously over the year. The purchases will also be consolidated to one supplier which allows for better cost control.

A final conclusion is that the material groups best suited for outsourcing are those whose demand is relatively smooth and frequent and where traditional inventory management methods can be applied. There is however an important difference compared to the inventory management of the main input used in the production (in this case recycled fiber) that is the low value of an average order. This means that a streamlined sourcing process is very important due to the handling cost to value ratio. This is the main reason outsourcing is attractive for these items, the 3PLPs specialization and expertise of spare part sourcing.

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Appendices

Appendix 1. Interview guide

Vill du först bara beskriva vad du gör i din roll här på Edet?

Beskrivning av nuläget

-Kan du beskriva hur processen av beställning av reservdelar (*lagerhantering och inköp*) fungerar i nuläget (vilka processerna är, speciellt vilka steg som är kostnadsdrivande (Inköp, administration/Beställning, fysisk hantering?) Från att man plockar ut en artikel tills att det är påfyllt (hur automatiserat/manuellt --- Finns rutiner – Dokument för hur det går till.)

- Hur skiljer sig hantering av reservdelar mot insatsvarorna? Några särskilda utmaningarna med dom? (tid lagt på det osv), (De typiska med osäker efterfrågan osv)

-(Många olika leverantörer?)

-Om vi tänker aggregerat för alla reservdelar; är åtgången jämn? Eller koncentrerad till Underhållsstopp?. Eller är underhållsstopp ett helt eget projekt fristående från den övriga verksamheten?

-Vilken är (den upplevda) servicenivån nu? Leder problem med reservdelshanteringen någonsin till problem för produktionen?

-Har ni någon uppföljning av reservdelshanteringen i nuläget? Ser man över och gör förändringar av hanteringen ibland? (ex av ROP, storlek på lager.) (Hur utvärderar man, hur ofta, har man några *KPI:er* man använder i nuläget?)

-Hur är kommunikationen/samarbetet generellt med leverantörer i nuläget? (hur ofta (möten?) ?, Speciallösningar, hur sker kommunikationen?)

Motiv/anledning till att undersöka outsourcing

-Vad är anledningen/motivet till att ni vill undersöka outsourcing som ett alternativ? (Kostnadsbesparingar bara? Andra sätt som man kan förbättra hanteringen/ser förbättringspotential i och kan skapa värde?)

-(hur kom man på detta? , någon specifik händelse eller problem?)

-(Strategiskt, focus på kärnverksamheten? Eller bara tror på operativa, konkreta, vinster)

-(Vilka kostnads minskningar kan du se?, Inköp, administration/Beställning, fysisk hantering?)

-Ur ditt perspektiv, vart tror du vinningarna finns med en extern leverantör som sköter outsourcing? Vad tror du de kan göra bättre?

- Vad får inte förändras, ska fortsätta vara som det är?

-Är alla artiklar av intresse, eller bara partiell outsourcing?

-(Varför? för vilka artiklar tror du att hanteringen kan förbättras mest?)

-(Vilken kunskap/kontroll är viktig att behålla inom företaget?)

Önskat resultat

- Hur integrerad vill man att extern ska vara? Om vi har en skala där Enklaste varianten att de sköter inköp och levererar till ”dörren”. Eller hela vägen till att fysiskt placerar varorna på rätt plats i lagret, samt kanske sköter själva lagerstyrningen med lämpliga nivåer på lager och ROP osv?
 - Vilken service ska ingå?
 - Kan du se några risker som blir viktiga att undvika (förlorar kontrollen) (ökat beroende)
 - Vilken information är det viktigt att kunna se från en leverantör? Vilken data gällande lagret är viktigt att ha koll på och att de delar med sig av? (Kostnader, lagernivåer, ledtider?)(Vilka KPIer)
 - Vad är viktigt/Hur viktigt med kommunikation och kontakt? Hur nära samarbete vill man ha/ang. uppföljning osv, hur högt värderar man det?
 - Är det något extra/viktigt/prioriterat som leverantören måste klara av att leverera på?
- Är det något jag missat att fråga om som du vill tillägga eller något som du vill poängtera att det är viktigt?

Appendix 2. AHP-Scores

Mat grp	Score
Tools, Utensils	72,6
Bearings	65,9
Pneumatic, Hydraulic	65,7
Steel Tubes	65,7
Spacers, Washers	65,7
Electrical Switches	65,0
Cleaners, Disinfect	65,0
Electrical Distrib.	64,3
Conduction, Insulat.	63,6
Hoses, Connectors	63,3
Semi-manuf Rubber	63,3
Protecting Elements	62,1
Drive Belts, Chains	62,0
Bulbs, Speakers	61,8
Welding, Soldering	61,4
Protect Cloth, Equip	60,9
Springs, Tighteners	59,6
Jets, Spray Nozzles	58,3
Semi-manuf Light Met	56,7
Lifts, Supports	55,8
Gears, Pulleys	54,8
Transmission devices	54,7
Cable Support	52,7
Means of Operating	48,7
Threaded Fasteners	45,4
Amplifiers, Transfo.	43,8
Electrical Feeding	43,7
Lubricants	43,3
Proc, Constr Machine	42,8
Semi-manuf Cast Iron	38,3
Electrical Componets	36,9
Paints, Lacquers	33,3
Building Elements	32,9
Pumps, Fans, Compres	28,5
Semi-manuf Wood	27,3
Other Eng Storeroom	24,9
Electrical Motors	19,4
Semi-manuf St Steel	12,6
Heat Production	10,0

Appendix 3. Sensitivity analysis

Value/Order Num Orders Vendors/Orders	Weights					
	0,6	0,4	0,33	0,7	0,5	1
	0,25	0,4	0,33	0,2	0,25	0
	0,15	0,2	0,33	0,1	0,25	0
Tools, Utensils	1	1	1	1	1	12
Bearings	2	4	9	6	7	10
Pneumatic, Hydraulic	3	2	5	8	4	14
Steel Tubes	4	7	16	2	9	2
Spacers, Washers	5	13	10	3	3	1
Electrical Switches	6	3	6	9	6	13
Cleaners, Disinfect	7	12	15	4	8	3
Electrical Distrib.	8	14	22	5	13	4
Conduction, Insulat.	9	16	23	7	15	5
Hoses, Connectors	10	9	18	10	12	7
Semi-manuf Rubber	11	15	8	11	5	8
Protecting Elements	12	10	14	13	14	11
Drive Belts, Chains	13	5	7	15	16	17
Bulbs, Speakers	14	19	17	12	11	6
Welding, Soldering	15	17	20	14	17	9
Protect Cloth, Equip	16	6	12	16	20	16
Springs, Tighteners	17	11	2	18	2	22
Jets, Spray Nozzles	18	20	11	17	18	15
Semi-manuf Light Met	19	18	4	20	10	23
Lifts, Supports	20	22	19	19	21	18
Gears, Pulleys	21	21	24	22	22	21
Transmission devices	22	24	25	21	23	20
Cable Support	23	25	26	23	24	19
Means of Operating	24	23	3	25	19	28
Threaded Fasteners	25	27	27	24	25	25
Amplifiers, Transfo.	26	28	29	28	27	27
Electrical Feeding	27	29	30	27	29	26
Lubricants	28	31	31	26	30	24
Proc, Constr Machine	29	26	28	29	28	29
Semi-manuf Cast Iron	30	30	21	30	26	32
Electrical Componets	31	8	13	33	31	37
Paints, Lacquers	32	34	35	31	32	30
Building Elements	33	35	36	32	33	31
Pumps, Fans, Compres	34	32	33	35	34	34
Semi-manuf Wood	35	36	37	34	36	33
Other Eng Storeroom	36	33	32	36	35	36
Electrical Motors	37	37	39	37	38	35
Semi-manuf St Steel	38	38	34	38	37	38
Heat Production	39	39	38	39	39	39

Examensarbeten / Master Thesis
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