Boost your spare parts supply

A case study on cooperation terms in the spare parts supply chain focused on the supplier-buyer dyad

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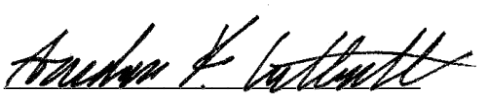

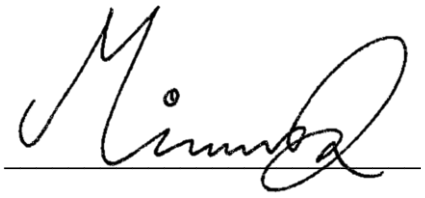

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Abstract

Purchasing has become an increasingly important function in manufacturing companies, as it accounts for a large extent of total spending and influences a company's competitive position. It is relevant for Tetra Pak, a global manufacturer of packaging and processing solutions, active since the 1950s. Tetra Pak has over 100.000 active units at customers site over the world, to service them and offer spare parts is both a significant source of revenue for Tetra Pak and a service requested by the customers. The customers expect fast responses, as breakdowns in the food industry have severe consequences. It implicates that a wide array of parts are needed to be made available with short notice globally. To achieve it, Tetra Pak is working with an adapted consignment stock strategy, referred to as the logistics agreement. It means that some suppliers hold materials in finished stock. It enables the suppliers to deliver with short lead times, with the condition that if Tetra Pak does not purchase the material according to forecast, Tetra Pak financially compensates the suppliers for the remaining stock. The purpose of the thesis was to understand how the logistics agreement worked, but also to understand the implications of the solution and determine if the strategy was beneficial to Tetra Pak. Further, the aim was to compare Tetra Pak's processes with literature and comparative companies and give improvement suggestions.

The research was initiated with a literature review to compile knowledge from research within purchasing, after-sales services, and spare parts management. Based on that, an analysis model was created. The model helped to analyze the empirical data by dividing the area into three different parts: the overall goals with the strategy, which spare parts should be included in the strategy, and which suppliers should be included in the cooperation.

The empirical data was collected mainly through interviews and quantitative analysis based on historical information from Tetra Pak's ERP. In addition to that, interviews were also conducted with strategic Tetra Pak suppliers and three comparative companies. With help from the structure of the analysis model, Tetra Pak’s processes were analyzed.

The conclusion was that an adapted consignment stock strategy is favorable for spare parts. It increases availability, which is the main KPI for parts, to the customer. The cost of increasing availability is substantially lower than the alternative, which is to keep the material in stock. The main challenges to succeed are identifying the materials that get an added benefit from the solution and finding terms of the agreement ensuring a manageable scope of materials and compliance from the suppliers.

List of Abbreviations

ASL	Approved Stock Levels
CSA	Customer Stock Analyst
DP	Delivery Performance
EOQ	Economic Order Quantity
EOQ POD	Economic Order Quantity Period
GPE	Global Planning Expert
KPI	Key Performance Indicator
LA	Logistics Agreement
LT	Lead time
LTH	Lunds Tekniska Högskola (Lund University - Faculty of Engineering)
MOQ	Minimum Order Quantity
OL	Order Line
PSC	Parts Supply Chain
ROP	Reorder Point
SCS	Supply Chain Specialist
SKU	Stock-Keeping Units
SuM	Supplier Manager
TPTS	Tetra Pak Technical Services

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1 Introduction

This introductory chapter will provide the reader with a background to the subject of the thesis, as well as the focus company. It will give information on the purpose of the study, and the research questions that needs to be answered to fulfil the purpose. Beyond that will it give information regarding how the master's thesis is conducted and what areas it intends to cover.

1.1 Background

To sell and produce has for a long time been a core function for manufacturing companies. However, for the last twenty years, competition has increased, and profit margins have declined. With that, the status and priority of purchasing have changed considerably (Van Weele, 2014). Companies have shifted focus from solely on sales to considering costs, and to manage purchasing is to manage expenditure (Van Weele, 2014, Kraljic, 1983, Levitt, 1983). With that change, top management has acknowledged purchasing as a critical business driver, and it has been increasingly incorporated in companies' overall strategy (Cohen et al., 2000). The change is not surprising; the average manufacturing company today spend 59 cents of every dollar on materials (Bozarth and Handfield, 2016). Improving the purchasing function's performance can significantly impact the bottom line, and beyond that, enable just-in-time deliveries, faster time to market, and improved quality (Kraljic, 1983).

The purchasing supplier dyad is the focal element of procurement. However, beyond that, in the current global scale-driven business environment, Choi and Liker (2004) argue that the supplier-buyer partnership is the lifeblood of the entire supply chain. To be a company that is easy to work with and favored by suppliers has become a crucial advantage (Cohen et al., 2000). The recent supply chain disruptions due to the Covid-19 pandemic have accentuated that development. Supply chains that have neglected risks such as lack of resilience and overfocus on cost have been severely exposed (Van Hoek, 2020).

One area where good supplier relationships are especially valuable is the after-sales. After-sales are defined as the support activities after the sale, including maintenance, training, and repairs (Durugbo, 2020). According to Durugbo, spare parts are often a dominant aspect of the after-sales for a manufacturing company, as spare parts sales are closely linked to high profit margins and profit contributions. Companies that can offer customers critical spare parts in time can also significantly improve customer satisfaction in the after-sales (Cohen et al., 2006, Cohen et al., 2000, Okamuro, 2001). To not only sell a service or a machine to a customer but to keep them happy over time with excellent maintenance and service enables long-lasting and prosperous relationships (Levitt, 1983). For a company, excellent after-sales is also a competitive advantage because happy customers are not likely to switch to competitors (Oliva and Kallenberg, 2003).

The requirements for managing spare parts are vastly different compared to other materials, such as materials for the production. Spare parts generally have a lower turnover rate, infrequent demand, and stockouts can have significant financial implications (Huiskonen, 2001). To be successful, a company would strive to offer high availability of parts without having it all on stock (Van Weele, 2014). To achieve it, factors such as supply chain resilience and short lead time are crucial, making close supplier collaboration a must (Huiskonen, 2001).

1.2 Company description

The authors have chosen the subject of spare parts purchasing and supplier collaboration as the main themes of the thesis. These themes will be investigated at the Parts Supply Chain (PSC) division at Tetra Pak. The placement of PSC can be seen in Figure 1.1.

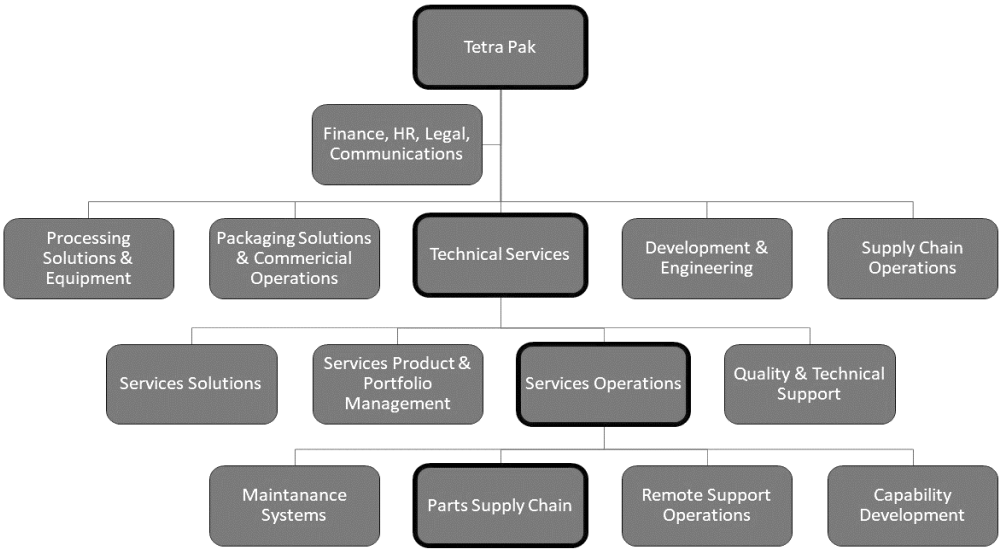

Figure 1.1 Tetra Pak company hierarchy (Tetra Pak, 2020).

Tetra Pak is a world leading company specializing in solutions for processing, packaging, and distribution of food products. Tetra Pak has a global presence with main facilities in Lund, Modena and Shanghai. Tetra Pak machines are delivered and serviced all over the world, with machines from the 1950s still active today. An essential part of Tetra Pak's business model is the after-sales. The ability to serve customers with production material, maintenance services, and spare parts separates Tetra Pak from their competition and has been strong factor for the company's success over the years.

Tetra Pak's division that is responsible for the after-sales services, including maintenance, spare parts, and reparation of the machines, is called Tetra Pak Technical Services (TPTS). PSC within TPTS operations (see Figure 1.1) is the unit responsible for the spare parts supply chain. They strive to achieve high availability and service level to Tetra Pak's customers while at the same time optimizing cost and risk. It is no easy task, as there are almost 100.000 active Tetra Pak machines in over 160 countries around the globe. For each machine, downtime can have severe implications for the Tetra Pak customer. To keep their customers happy and to maintain their market position, PSC performance is intricate to the company's overall success (Tetra Pak, 2021).

The Planning & Quality team is part of the PSC team and is tasked with securing the global availability of spare parts to meet ever-changing customer demand. The responsiveness to customer requests is expected to be much more agile than its production counterpart. Tetra Pak has realized the strategic value in providing the services needed to keep their customers' downtime to a minimum, and TPTS managed to be the only business area to see growth in revenues through the Covid-19 pandemic in the year 2020 (Tetra Pak, 2021). A good model for collaboration with suppliers and a modern logistics platform is needed to ensure that TP delivers according to their customer's expectations.

1.3 Problem description

Historically, the purchasing function at Tetra Pak focused on securing the best possible performance for the internal production, and as a result, spare parts were down prioritized. Around 15 years ago, several changes were made to improve PSC's performance. Purchasing for service material was transferred to a separate unit, as shown in Figure 1.2, which enabled new solutions that worked better in the spare parts sourcing environment. With that, the current working methodology was established.

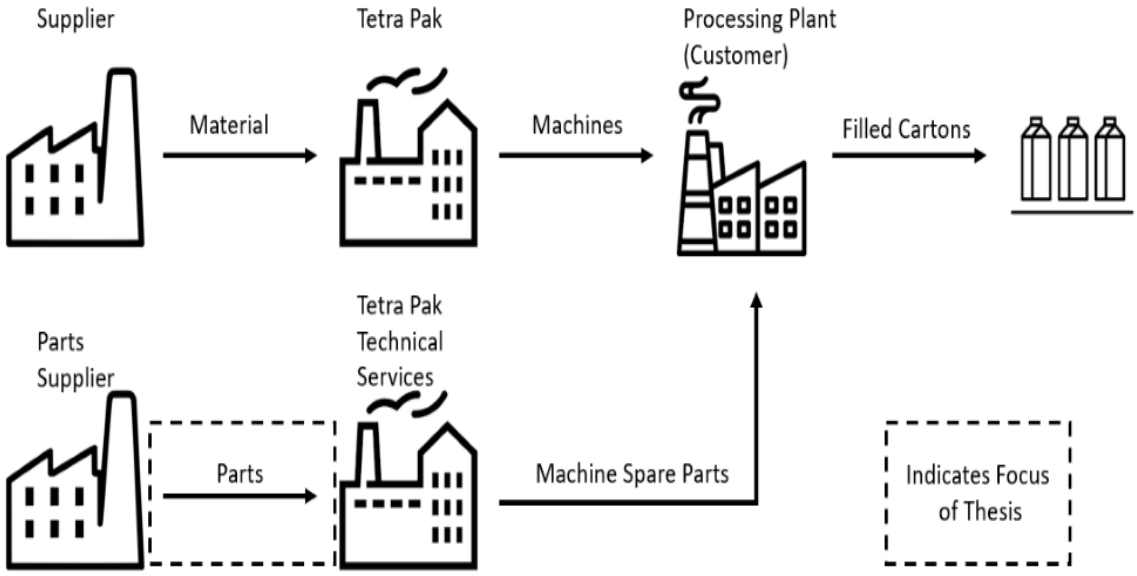

Figure 1.2. Tetra Pak's different business units and stock flow with the indicated focus of the thesis.

TPTS has a general goal: they want 14 days lead time from their suppliers and 96 percent delivery performance. The delivery performance means the percentage of order lines that are on time and in the right quantity. These goals are especially true for their high runner materials, which are derived from a set of criteria, and are labeled as Approved Stock Level (ASL) materials. However, some suppliers may struggle with delivering according to the staked-out goals. To improve, PSC can suggest that the supplier build up stock to shorten their lead times and improve delivery performance. If the supplier is unwilling, Tetra Pak may offer the supplier a risk-sharing solution. The condition is that if the supplier builds up three months stock of ASL material, Tetra Pak commits to buying the built-up stock. The solution is designed to help suppliers get financial security for building stock to meet PSC's delivery requirements, and the terms of the contract are stipulated in the logistics agreement (LA).

In recent years, certain problems with the current working methodology have presented themselves. The number of logistics agreements has increased, and many materials that are not critical to PSC still have a warranty to be bought through the logistics agreement. The high amount and continuous changing of materials affected by a logistics agreement have led to TPTS having issues with overseeing the financial risk they take on through using the logistics agreement. A volatility of the scope of materials also complicates TPTS possibilities to follow up on performance and compliance of the agreement's terms. The logistics agreement has been

improved over time, which has increased performance but at the cost of accumulating complexity. Therefore, it has been hard to enact improvements, and the suppliers are sometimes struggling to understand the terms of the contract. It has created a need to review and potentially revise the current logistics agreement to find the best practice working method that fits the modern world while still delivering on key performance indicators.

1.4 Purpose of study

The purpose of the master's thesis is to assess how a manufacturing company participating in after-sales services can improve buyer-supplier agreements, i.e., the logistics agreement.

To fulfill the purpose, three research questions have been formulated specific to the problem presented. The context in which the research questions will be answered is the purchasing process, spare parts management, and supplier collaboration.

Research Questions:

1. *What are the advantages and disadvantages with the current logistics agreement?*
2. *How can the logistics agreement be improved in terms of scope and classification of spare parts?*
3. *How could a general model be formed as guidance for future logistics agreements?*

1.5 Focus and delimitations

The focus of the master's thesis was spare parts purchasing, stock management, supplier collaboration, and financial risk-sharing as processes for ensuring after-sales services. As PSC at Tetra Pak initiated the project, the scope was linked to PSC and their supply chain. Furthermore, the focus was primarily on developing a deep understanding of the present logistics agreement between PSC and suppliers and how the areas mentioned above are affected by the logistics agreement, and identify shortcomings that can be improved upon. The new strategy was developed with consideration to the financial impact, service performance, and stakeholder interests. Since TPTS has global operations with multiple distribution centers and supply sources, certain delimitations regarding geographical and organizational scope need to be done to ensure that this study was performed during the limited time.

PSC was the focal point within Tetra Pak, and as a result, the focus was on spare parts purchasing and not the full Tetra Pak nor TPTS operations, see Figure 1.1. As a result, only suppliers delivering to the spare parts supply chain was be included in this thesis' scope. The thesis' focus was the sourcing of spare parts, and warehouses that only distribute are excluded from the scope. There are two warehouses in the parts supply chain that receive shipments from suppliers, Lund and Shanghai. The Shanghai warehouse is solely responsible for Asian suppliers, while the Lund warehouse sources and distributes globally. Therefore, the authors, together with PSC decided to only focus on the Lund warehouse, which should still give ample enough base for the research.

The unit of analysis for the thesis is buyer-supplier agreements for Tetra Pak's spare parts. The indicated focus can, therefore, be seen in Figure 1.2.

1.6 Thesis outline

The thesis was divided into seven chapters. The first chapter is an introduction to the thesis subject, in which the background was presented. It includes a description of the case company, stating the purpose of the study as well as focus and delimitations to the study. The second chapter of the thesis is the methodology chapter. It presents the choices regarding research methods together with the reasoning behind the selections. The third chapter overlooks the literature review conducted during the thesis, examining current research within key areas pertinent to the research subject culminating in an analytical framework. In the fourth chapter, the empirical data of the study is presented. This chapter focuses on data gathered from the case company and shares some findings from comparative companies. Fifth is a chapter with an analysis of the literature and empirical data, using the analytical framework from the third chapter as a base for the analysis. The sixth chapter focuses on discussing the gaps found in the case company's practices in comparison to literature, with potential solutions to those gaps. Lastly, the final chapter contains the conclusions of the findings together with answers to the research questions. The chapter also looks at the thesis' contribution to theory and practice before concluding with suggestions for future research.

2 Methodology

This chapter will share how the research for the master's thesis is conducted. It will explain different approaches in key areas, and then motivate and state the method chosen for this thesis, based on the purpose and the unit of analysis. It will also discuss how research data for the study was collected and evaluated to ensure high credibility for the master's thesis.

2.1 Research approach

The research approach determines how the research is planned and carried out. There are two prevalent, separate ways of conducting research, the *inductive* and the *deductive* approach.

The inductive approach is a method of researching to understand a phenomenon in its natural context, which in this case is buyer-supplier agreements for Tetra Pak's spare parts. The focus is generally qualitative in its nature and includes three steps as described by Kotzab et al. (2006), see Figure 2.1. The first step is for the researcher to inspect and understand the phenomenon through data collection, usually done with field visits and interviews. The next step is to understand and describe the phenomenon's deep structure using multiple data sources collected to gain a firsthand understanding. In the third step, a substantive theory can be generated, usually through a process model that leads back to the phenomenon.

The deductive approach instead has a more quantitative focus (Kotzab et al., 2006). The first step is to do a literature review, creating a framework where key variables and relationships are extracted. The second step is to create formal theory from the literature review and generate hypotheses regarding the phenomenon. In the final step, these hypotheses are either validated or discarded with quantitative data to generate conclusions that connect back to the phenomenon.

There is also a combined method, called the *abductive* approach, also referred to as the balanced approach, in which the research iterates between the abductive and deductive approach (Kotzab et al., 2006). In the balanced approach, a researcher generally develops a theory with the inductive approach, which is validated with the deductive approach. The main advantage is that the scope is not delimited, and by utilizing both methods, the research benefits from both a qualitative and quantitative perspective. It gives width and depth to the research.

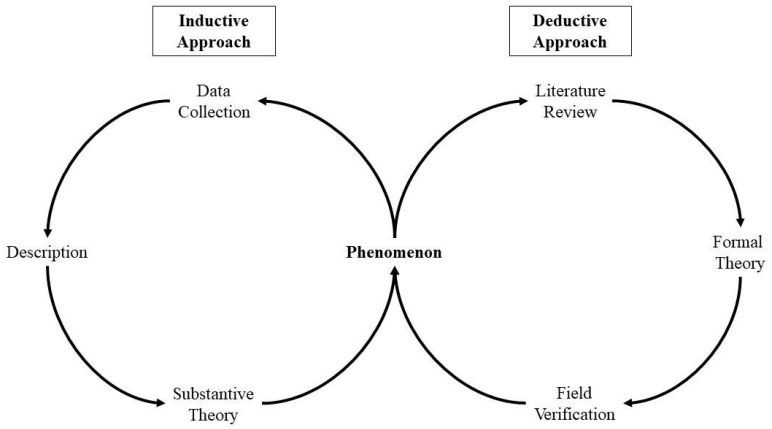

Figure 2.1. The balanced approach model (Kotzab et al., 2006).

The chosen approach for this project was the balanced approach. From the start of the project, it was not clear which were the relevant factors, business units, and parameters. The project, therefore, started with an inductive approach that formed the base for understanding the buyer supplier agreements at Tetra Pak and continued with developing the substantive theory. Then the relevant theory and understanding was continuously validated through the deductive approach.

2.2 Research method

The research method is the strategy, techniques and process that is used in the thesis to collect evidence and data to gain a thorough understanding about the topic (Kotzab et al., 2006). It is, therefore, crucial for the relevance and quality of the thesis to choose an appropriate method.

2.2.1 Types of research methods

The research method should be chosen depending on the purpose and the type of research. Höst et al. (2015) proposes four different types of purposes for research:

- *Descriptive* – A description of the phenomenon once research of the topic already exists.
- *Exploratory* – Aims to understand the phenomenon by answering how and why the issue occurs.
- *Explanatory* – A combination of the descriptive and exploratory study that give descriptions and explanations of the phenomenon.
- *Problem Solving* – Aims to solve a selected problem.

According to Yin (2002), there are five different methods to achieve the purpose, see Table 2.1. Three criteria decide the appropriate method; type of research question, if behavioral events can be controlled, and the focus timeframe.

Table 2.1. Different research methodologies for various scenarios (Yin, 2002).

Strategy/Method	*Form of research question*	*Requires control of behavioral events*	*Focuses on contemporary events*
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/No
History	How, why	No	No
Case study	How, why	No	Yes

When choosing a research method, there are always trade-offs (Kotzab et al., 2006). The choice of methodology depends on what is to be achieved by the research. However, the methods are not exclusive, meaning that more than one method can be used in a project (Yin, 2002). In Table 2.1 two methods stand out due to their exclusivity. The experimental method is the only one that requires control of the behavioral events in the study and the historical method is the only one that never focuses on contemporary events.

When reviewing the three other methods, there are pros and cons with each method. Survey research is an efficient method to collect data, frequently using questionnaires (Kotzab et al., 2006). Surveys yield standardized data that is easily comparable, but a downside is that it alone does not reach the same depth of analysis compared to a case study (Yin, 2002). A general definition of the case study is an empirical method that examines contemporary events (Kotzab et al., 2006, Yin, 2002). It has the advantage of identifying and describing critical variables that make it appropriate in the supply chain context. With the identification of critical parameters, a theoretical foundation can be built to uncovers deep root causes of the current situation instead of only the result itself (Yin, 2002).

The goal of the thesis was, as stated previously, to provide an in-depth contextualized analysis as to how well the current situation works and how it can be improved. The purpose of the study was therefore exploratory.

Regarding the method, one option could instantly be ruled out for this thesis. There was no possibility to control behavioral events, which disqualified the experimental method. A typical historical method was not used either, as the focus of the project was on contemporary events, but elements of this method was used as some historical company data was needed for the analysis. Further, Voss et al. (2002) argue that in-depth case studies are the best research strategy for an exploratory purpose. As the case study was the method most in-line with the research's expected goal, it was selected for the thesis. The only case with substantial data that was available was Tetra Pak, why the thesis is a single case study. Beyond that, an archival analysis was included as part of the case study was to analyze qualitative and quantitative data from the case company’s records.

2.3 Research data

As both the research approach and research methods have shown, an important part of a study is the data used. There are multiple methods for collecting and evaluating research data. In this thesis three main methods for data collection have been in use: literature review, interviews, and company data. The reason behind the choice of these three was to have both quantitative and qualitative data which correspond with the balanced approach. Beyond that has a section of data validity and data analysis been included to ensure trustworthiness in the thesis.

2.3.1 Data collection

Literature Review
The foundation to conducting a deductive case study, which is a part of the balanced approach, is the theory development (Yin, 2002). That is why a thorough literature study was included in the master’s thesis. A literature study aims to conclude what is known about the subject, and it

should connect to the research questions (Thomé et al., 2016). The literature review itself should be done in two stages. The first step is to get a holistic overview of the subject, while the second step focuses on in-depth knowledge (Höst et al., 2006). For the literature review, a key area is to work with a systematic approach to find all relevant research. Rowley and Slack (2004) suggests four different strategies to find relevant literature:

- *Citation pearl growing* is a strategy where the researcher selects one or a few key documents. From those documents the researcher identifies suitable citations or terms to expand and find more literature that are used to develop the literature base further.

- *Briefsearch* which is the strategy of quickly and crudely retrieving a few numbers of documents. Often a good starting point for further work.

- *Building blocks* uses related terms and synonyms to concepts in the initial search statement to widen the search universe, which may be a time-consuming exercise but leads to a comprehensive set of documents.

- *Successive fractions* is a method to reduce a large set of already retrieved documents, by searching within the set to eliminate the less relevant or useful documents.

For this thesis, citation pearl growing has been used. Documents from initial articles were tracked down using journal and article databases that are available to university students, such as LUBsearch and Science Direct. To further ensure the reliability of the documents, as suggested by theory, two factors were considered. The age of the material, since some studies might lose relevance as time passes (Brewerton and Millward, 2001), and whether the document itself has been sufficiently peer-reviewed or not (Höst et al., 2006).

Interviews

One of the most important sources of information for case study research is the interview (Yin, 2002). The reason behind this, according to Yin, is that interviews can manage to focus directly on the case study topic as well as provide perceived causal inferences. When conducting a research interview, the interview can have three fundamental forms (Gill et al., 2008, Höst et al., 2006):

- *Structured interviews* are often likened to verbally performed questionnaires, where the questions are set in advance and rarely changed between interviewee subjects. It gives quick and easily administered interviews, as there is no scope for follow-up questions or further elaboration. The very nature of the structured interview makes it unfit when depth from the interview is needed.

- *Unstructured interviews* are much the opposite and can instead be likened to an open chat around a topic of interest with no predetermined questions to use as guidance. The interview will often progress based on the response given to the question before and can be useful for when great depth is needed or virtually nothing is known of the topic ahead of the interview. This can lead to long interviews and can be difficult to manage.

- *Semi-structured interviews* are a mix of the two forms above, with both predetermined questions and open follow-up questions. The predetermined questions are often used to help define areas to be explored in the interview and then the open questions allow for discovery or elaboration of information that appear in the interview. This interview

format gives the interviewer some guidance of what to talk about, while also having the flexibility to pursue depth in chosen topics.

In this thesis, interviews have been held with a variation of people, focusing but not limited to PSC staff, Tetra Pak's spare parts suppliers and comparative companies (for full list of interviews, see Table 2.2). The suppliers and comparative companies were selected after the consultation of Tetra Pak and supervisors. Two forms of interviews, unstructured and semi-structured, was used to conduct the interviews. Unstructured interviews were mainly used when talking to PSC and other Tetra Pak internal staff, as those interviews were used to understand the research topic and to set the scope of the research. For the interviews with external sources the semi-structured form was used, in-order to achieve some conformity and base in the responses, while leaving room to investigate certain areas of interests that arose in the interviews. Before conducting the semi-structured interviews, interview guides were created and shared with supervisors at LTH and Tetra Pak to receive approval on the appropriateness of questions. The interview guide for the semi-structured interviews can be found in Appendix A and Appendix B**.** During the thesis, follow-up meetings and presentations were held with Tetra Pak staff that did not adhere to the interview format, but helped in validating the findings.

Table 2.2. List of interviews.

Date	*Interviewee*	*Form*
2021-01-20	Supply Chain Specialist A	Unstructured
2021-01-20	Global Planning Expert A	Unstructured
2021-01-21	Supply Chain Specialist B	Unstructured
2021-01-29	Manager PSC	Unstructured
2021-02-02	Supplier A	Semi-structured (supplier)
2021-02-03	Supply Manager A	Unstructured
2021-02-04	Supply Chain Specialist C	Unstructured
2021-02-24	Global Expert Advisor A	Unstructured
2021-02-26	Supplier B	Semi-structured (supplier)
2021-03-02	Supplier C	Semi-structured (supplier)
2021-03-05	Supplier Quality Engineer A	Unstructured
2021-03-05	Global Planning Expert A	Unstructured
2021-03-18	Comparative Company A	Semi-structured (comparative)
2021-03-22	Comparative Company B	Semi-structured (comparative)
2021-03-25	Supply Chain Specialist D	Unstructured

2021-03-30	Customer Stock Analyst A	Unstructured
2021-04-06	Comparative Company C	Semi-structured (comparative)
2021-04-07	Supply Manager B	Unstructured
2021-04-13	Supplier D	Semi-structured (supplier)
2021-04-14	Supplier E	Semi-structured (supplier)
2021-04-15	Supplier F	Semi-structured (supplier)
2021-04-20	Supply Chain Specialist A	Unstructured
2021-04-21	Supply Chain Specialist E	Unstructured

When conducting interviews and multiple interviewers are present, Voss (2002) suggests that one person may take the lead interviewer role while the other focus on taking notes. This concept was followed by the authors, with the use of tape recorder as a back-up. Due to the presence of Covid-19, all interviews were done as video-calls through Microsoft Teams, in an effort to keep an environment as close to face-to-face interviews as possible. Further, it was important to conduct the interviews within the specified time, be respectful, and be a good listener while sticking to the questions during the interviews, as is the suggested approach by Creswell (2007).

Company Data

For the project, Tetra Pak provided quantitative data, categorized by Yin (2002) as archival data. It was mainly collected with the use of business objects reports, where data from Tetra Pak's ERP (Enterprise Resource Planning) could be filtered and directly extracted into Excel sheets. The Excel sheets made all product information and purchasing data available for different time periods. The data shared in the report have been scaled, to ensure confidentiality of the internal company data. There were also instances during the interviews with Tetra Pak staff where the interviewee suggested further reading or documents that could be useful for understanding certain topics. In those cases, the authors obviously happily collected those documents. The quantitative data was a valuable complement to the qualitative data, allowing for mapping of the current situation and to validate and question findings from the interviews (Yin, 2002).

2.3.2 Data credibility

The credibility of the information gathered during the research process is not something to be taken for granted, and it is the researcher's task to demonstrate the credibility (Denscombe, 2010). A conventional way to judge the credibility of research, according to Denscombe, is to look at four bases:

- *Validity* - Refers to the accuracy and precision of the data, as well as how appropriate the data is in terms of the topic that is researched. There are four separate quality tests for research, three of which fall with-in the theme of validity, namely *construct, internal, and external validity* (Yin, 2002). The regular meetings the authors have had with supervisors to discuss the relevance of the data is an example of how validity can be ensured during research.

- *Reliability* - Refers to whether a research instrument is neutral in its effect and consistent across multiple occasions of its use. This is the fourth test put forward by Yin (2002) that is used to establish the quality of the research, aiming to demonstrate that the same result would be reached if the operations of the study were repeated.

- *Generalizability* - Concerns the ability the research findings have in explaining, or occur in, similar phenomena at a general level rather than being unique to the case being studied in the research. Case studies has sometimes been criticized for the lack in ability to generalize the results, so it is important that the research rely on analytical generalization, connecting the case specific results to some broader theory (Yin, 2002).

- *Objectivity* - Refers to the extent the researcher's values and pre-conceived perceptions influence the research. It may also refer to the level of bias in the research data. One area that is subjected to risks of bias is in qualitative data such as interviews. Therefore it may be a reasonable approach to corroborate interview data with other sources and to make sure that the interview questions do not lead the interviewee to an answer (Yin, 2002).

The data in this thesis have been evaluated against these four bases. To further increase the credibility of the study and compensate for some of the weaknesses in qualitative data, the authors have used the method of triangulation. Denscombe (2010) describes triangulation as the practice of having multiple perspectives on the data by using different methods and different sources within the study. A usual way to enact triangulation is to compare results found through qualitative methods with the results from quantitative methods, as well as looking at if different sources within a method corroborate each other. In practice, this study has used three different methods, with multiple sources within each method, and has compared the findings to each other to identify possible discrepancies or weaknesses.

2.3.3 Data analysis

The analysis of the qualitative and quantitative data is an important part of the research methodology. Yin (2002) suggests that it is essential for a case study to have a solid strategy for analysis, yielding priorities for what to analyze and how. Eisenhardt (1989) describes a process for analysis that is highly iterative and closely linked to the data, where the iteration between theory and data will only stop once saturation is met and the incremental improvements

of continuing the analysis are minimal. This fits well with the views of Miles and Huberman (1994) who describes a model for data analysis that uses an iterative process between three concurrent flows of activities, which is shown in the model below:

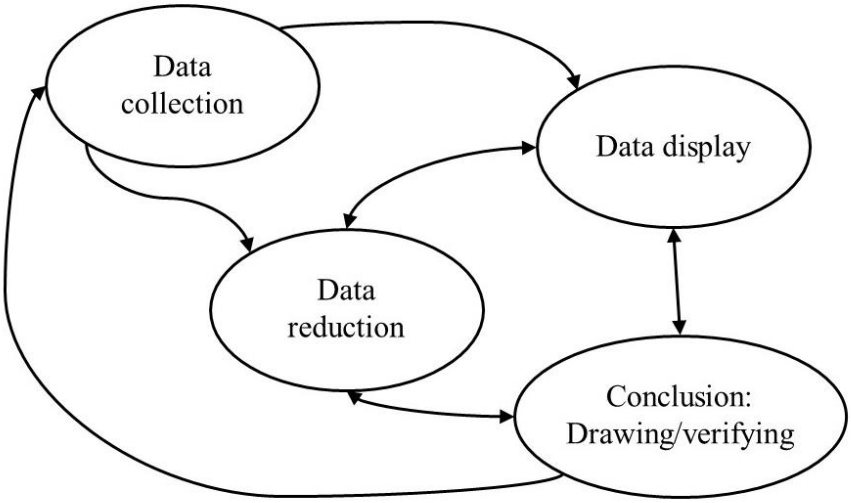

Figure 2.2. Components and flow within data analysis (Miles and Huberman, 1994).

As shown in Figure 2.2, all three activities are interconnected with the collection of data and each other. *Data reduction* is the process of simplifying, sorting, focusing, discarding, and organizing data, which makes the selected data stronger. *Data display* is an organized, compressed assembly of information that enables conclusion drawing and action, generated through analytical choices of what data and in which form (i.e., matrices, diagrams and graphics) the data will be presented. *Conclusion drawing and verification* comes from the researchers interpreting what the data means by noting patterns, causal flows and possible configurations, while continuously verifying the validity of the conclusions. One activity can lead to the need of performing another activity, and the researchers move along the nodes of analysis until a form of saturation is found and the final conclusions can be drawn (Miles and Huberman, 1994).

Although Miles and Huberman focus on the qualitative data analysis, the authors believed that the ideas of data reduction, data display, and drawing and verifying conclusions appropriately could be extended to quantitative data too. These ideas were, therefore, adapted to the processes used in the master's thesis for analyzing qualitative and quantitative data.

The empirical data that was collected during the master's thesis were both of qualitative and quantitative nature. The analysis of the qualitative data was based on the literature and analysis framework that is presented in Chapter 3. Each area of the framework was analyzed and discussed from the similarities and differences the empirical data had to theory in order to draw conclusions. The quantitative data was analyzed in Excel and the findings that could be drawn from this data was also put in contrast with the qualitative and the theoretical findings to draw further conclusions.

3 Theoretical Framework

The theoretical framework chapter will provide the necessary theoretical findings needed to answer the research questions. The framework is centered around three subjects that are critical to understanding factors for succeeding in the after-sales. The three subjects are purchasing, spare parts management, and supplier collaboration. Theoretical understanding of these subjects is necessary, as this thesis's research looks at how a manufacturing company can improve its after-sales services through better spare parts management and using supplier agreements. The importance of after-sales services will also be presented since it is the driver behind the need for understanding the three subjects. Lastly, a conceptual model for supplier agreements is presented, later used to analyze the case company.

3.1 Frame of reference

It has famously been said that competition nowadays is not between companies, but rather between supply chains. The statement accentuates the development that companies have gone from focusing on sales to instead extend the focus to how value is created along the entire supply chain (Van Weele, 2014, Carr and Smeltzer, 1999). The focal company of the study is Tetra Pak, and more specifically TPTS who are responsible for the after-sales service. For TPTS there are several important aspects of their supply chain where they look to create value in order to succeed with their after-sales service, and some of them represent the focus of this thesis (Figure 3.1). As mentioned in Chapter 1, the purpose of this master's thesis is to assess how a company like Tetra Pak can improve their buyer-supplier agreements, especially by looking at their purchasing process, spare parts management, and supplier collaboration. The expected outcome is to improve work efficiency, financial risk distribution, and supplier relationships, while minimizing complexity within the after-sales supply chain.

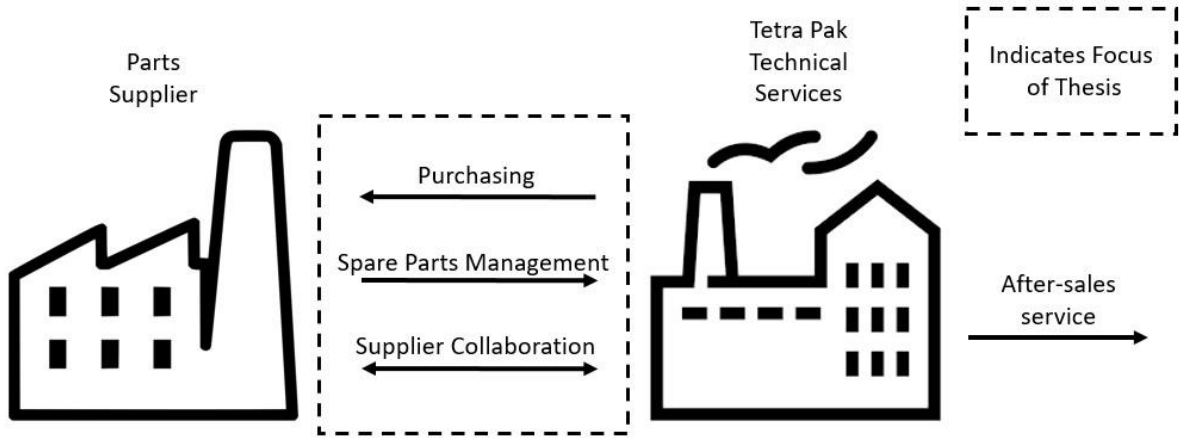

Figure 3.1. Activities between TPTS and their parts suppliers that help with ensuring availability of spare parts for after-sales service.

3.2 Purchasing

One area of supply chain management whose strategic importance has particularly increased over time is purchasing (Bozarth and Handfield, 2016). The definition of purchasing is how a company manage their external resources to support its activities in the most favorable way (Van Weele, 2014). Companies today spend more than half of their resources on material and services (Bozarth and Handfield, 2016). The performance of the purchasing function is fundamental to both the profitability and the long-term competitive position of the company (Paulraj et al., 2006).

3.2.1 Purchasing strategy

As companies have started to focus on supply chain management and purchasing, there has been an increased interest on strategic purchasing (Carr and Smeltzer, 1999). The case company of the master's thesis is multinational with complex decision structures. To understand the company's purchasing strategy, and how it affects their way of working will be relevant to assess the current performance and how improvement initiatives can be implemented. It is a vital subject to cover as companies with well-developed purchasing strategies perform better in supply chain management, customer responsiveness, and financial performance (Paulraj et al., 2006, Chen et al., 2004). The definition of strategic purchasing is, according to Van Weele (2014), how companies incorporate and align purchasing with the organizational structure and overall goals of the company. Van Weele argues that different purchasing categories need different strategies for purchasing.

To help management work with purchasing categories, Kraljic (1983) proposed four different product segments, together making up the purchasing portfolio. To treat each segment with the right amount of resources, there are different strategies described by Van Weele (2014):

- *Strategic items* - Products critical to the company's performance, as small increases in price can have a massive impact on the bottom line. Generally, for these types of products the company is dependent on few suppliers, and there is a risk of disruption of the material flow. The combination of profit impact and supply risk supports coordinated purchasing, where strategic alliances are developed with the supplier. The key to this strategy is to identify the best-in-class suppliers to cooperate with early in the product development.

- *Bottleneck items* – Items with less impact on the bottom line, but only a few suppliers can deliver the materials which increases the supply risk. The appropriate strategy is to secure continuity of supply at the lowest additional cost. It includes working long term to reduce the dependence on suppliers and to look for alternatives.

- *Leverage items* - For these items, the supply risk is low while the impact on the bottom line is high. It supports an approach where the focus is to get the best possible price. The company should leverage all their buying power, using several suppliers to get the best price. Therefore, there is no need to develop long-term contracts.

- *Noncritical items* - These products are routine products that have high availability and minimally affect the bottom line. The focus should be to minimize the resources spent on these products. Different strategies to optimize the process could be E-commerce options or outsourcing the purchases to a third party.

To choose the right strategy is incremental to unlock potential purchasing savings. To do so Van Weele adapted the Kraljic matrix with the corresponding strategy for each product segment (Figure 3.2).

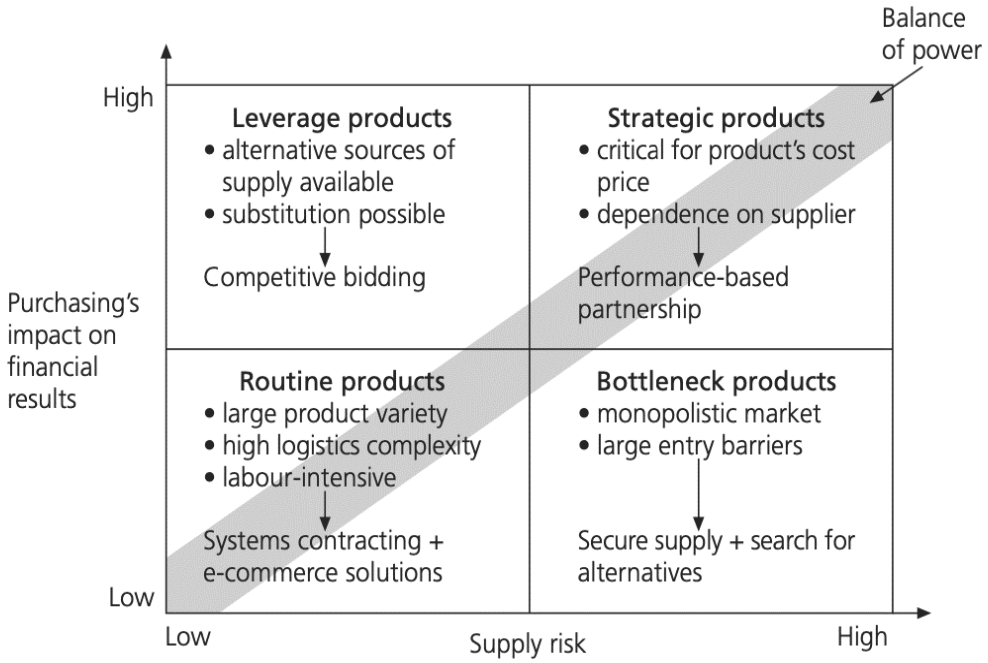

Figure 3.2. The Kraljic matrix adapted by Van Weele. It describes different product categories and their corresponding sourcing strategy (Van Weele, 2014).

However, strategic purchasing can also foster a clarity, which can improve the relationship with suppliers. Chen et al., (2004) argue that purchasing strategies helps companies to improve relationships with suppliers, promote information sharing and creates a basis for a long-term strategic orientation.

3.2.2 The importance of sourcing strategies

An incremental part of the purchasing strategy is how material is sourced. When selecting a sourcing strategy, the attributes of the material should be considered, as different methods have varied strengths and weaknesses (Van Weele, 2014, Bozarth and Handfield, 2016). Single sourcing means that only one supplier is selected to source a material, while multiple sourcing means that a company relies on several suppliers to source a material (Bozarth and Handfield, 2016). The advantages and disadvantages of the approaches are compiled in Table 3.1. Different advantages and disadvantages from single sourcing compiled from Bozarth et al. (2016) and van Weele (2014).

Table 3.1. Different advantages and disadvantages from single sourcing compiled from Bozarth et al. (2016) and van Weele (2014).

Single sourcing		Multiple sourcing	
Advantages	*Disadvantages*	*Advantages*	*Disadvantages*
Strong relationship with the chosen supplier	Dependence on the performance of a single supplier and high risk in case of disruption	Possibility to put pressure on suppliers to negotiate the best price	Difficult to get commitment and loyalty if you have several suppliers
Transportation economics, and a non-complicated logistics flow	Limited opportunities to get the lowest price	In case of problems with a supplier, they can easily be replaced	Increases time spent on managing suppliers and administrative duties
Economics of scale is reflected in lower prices	Lost supply market knowledge	Makes a broad competence base available which improves flexibility	Increasingly difficult to maintain a constant quality, as suppliers can deliver slightly different materials

There are also combined methods that can help companies overcome the dilemma of choosing single or multiple sourcing (Bozarth and Handfield, 2016). In *cross sourcing*, or *parallel sourcing* as it is also known as, a company uses a single supplier for each product but has several suppliers with similar capabilities (Bildsten, 2016). If one supplier's performance drops or there are disruptions, other suppliers can step in. The suppliers are awarded business based on their performance, creating incentives for improvement. *Dual sourcing* is when a company uses two suppliers for the same product, generally with an approximate 30/70 split of the business (Bozarth and Handfield, 2016). The suppliers are informed that they will lose business if they cannot achieve a competitive price and high performance. Bozarth and Handfield argue that both strategies achieve economies of scale benefits while at the same time capturing some of the advances of single sourcing. Balancing the choice of sourcing method is a complicated task that encompasses supply chain risk, dependency of suppliers, and sourcing cost. The choice of strategy must therefore be made on the highest managerial level (Van Weele, 2014).

3.2.3 Levels of purchasing decisions

The focal company of the thesis has several managerial levels and divisions in purchasing, with different responsibilities. Understanding the purchasing levels and how they interact will foster an understanding of the purchasing function decision-making process. In academia, there are

generally three levels of purchasing presented, operational, tactical, and strategic, as shown in Figure 3.3 (Van Weele, 2014).

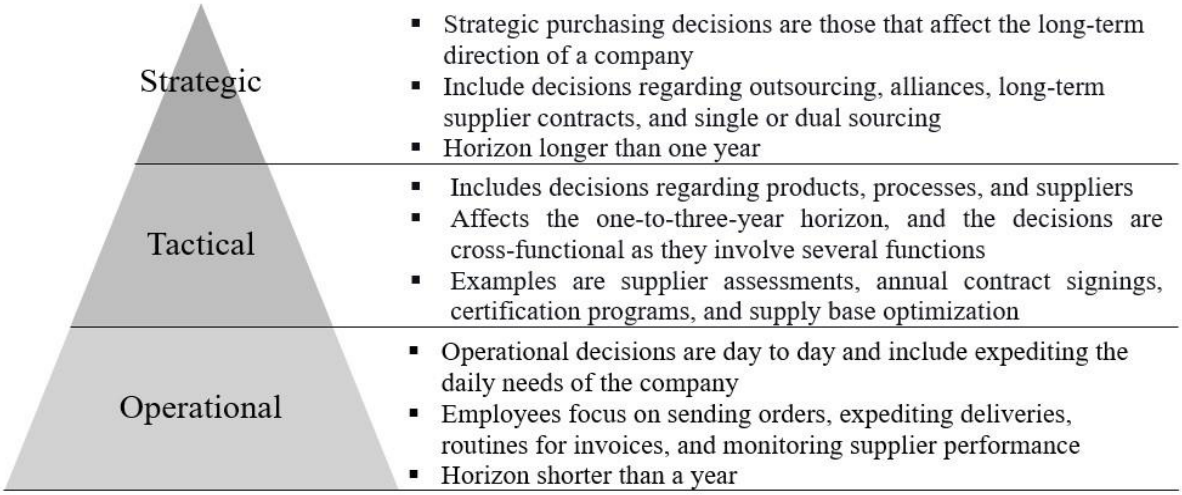

Figure 3.3. The three levels of purchasing decisions, adapted from (Van Weele, 2014).

To map strategic tactical and operational purchasing areas helps companies to implement their purchasing strategies (Paulraj et al., 2006), and when aligning purchasing synergy initiatives with the overall business strategy, the likelihood of success increases (Rozemeijer et al., 2003).

3.3 The value of after-sales service

There is a unanimous opinion in management literature for companies to include after-sale services in the core product offering (Johansson and Olhager, 2004, Cohen et al., 2006, Levitt, 1983). The companies that perform the best today are those that extend their focus from just producing the product with the lowest price or highest quality to capturing the customer's need for service during the full lifetime of the purchased product (Cohen et al., 2006).

Olhager and Johansson (2004) define after-sales as "The supply of after-sales services, including tangibles such as spare parts and consumables, related to the maintenance of industrial goods". Cohen and Lee (1990) define it as "[…] the activity that supports products after they are delivered to customers". However, these definition does not capture all aspects of after-sales.

According to Oliva and Kallenberg (2003) there are three main reasons to engage in after-sales. The first argument is the financial, as an installed product base will continue to generate revenue over its entire lifecycle. The after-sales' profit margin is higher than for manufacturing, and the business is stable, in the sense that it is not affected by economic cycles. Hence, it helps the company with creating stable income over time. Second, customers are generally demanding more service, and to not deliver after-sales could be a weakness. Not delivering all that the customers requests could potentially make the company less attractive to select as a supplier. Finally, it is hard to imitate good service, and companies that have excellent after-sales are more likely to keep their customers over time. It is validated by Durugbo (2020), who agrees that delivering after-sales is a competitive advantage, which can give additional revenue streams.

As mentioned earlier, the companies that perform best in the after-sales can capture all the customer's needs for service, as it is not enough to deliver the highest quality or lowest price. Cohen et al. (2006) describe after-sales as a long lasting low-risk source of revenue. Cohen also argues that increasing the after-sales income takes less work than finding new customers and markets. Levitt (1983) mean that the sale is just the start of a relationship. It can therefore be summarized to that the after-sales are crucial to the customers impressions; a sale is just a short interaction, while the after-sales can last for decades.

3.4 Spare parts management

One area of the after-sales that is particularly attractive is spare parts. It is because spare parts generally have higher profit margins than direct material and can be attributed to substantial profit contributions (Cohen et al., 2000, Huiskonen, 2001, Wagner and Lindemann, 2008).

To deliver spare parts is often more complicated compared to traditional manufacturing products due to the parts' unique features, see Table 3.2. Spare parts are difficult to forecast and become obsolete as equipment is retired (Wallin Blair et al., 2020). As each generation of product requires different materials, the number of stock-keeping units (SKU) increases dramatically over time and are often 20 times the number of direct materials (Cohen et al., 2006). For selling spare parts, the service requirements are also vastly different from direct material (Cohen et al., 2000). The customer expects an immediate response and short delivery times for orders, as downtime can have substantial financial consequences for the machine owner. The main performance metric is product availability, instead of fill rate that is used for traditional supply chains.

Table 3.2. Comparison between an manufacturing and an after-sales services supply chain with different parameters (Cohen et al., 2006).

Parameter	Traditional supply chain	After-sales supply chain
Nature of demand	Predictable, can be forecasted	Always predictable
Required response	Standard, can be scheduled	ASAP (same or next day)
Number of SKUs	Limited	15-20 times more
Product portfolio	Largely homogeneous	Always heterogeneous
Delivery network	Depends on nature of the products; multiple networks necessary	Single network, capable of delivering different service products
Inventory management aim	Maximise velocity of resources	Pre-position resources
Reverse logistics	Does not handle	Handles return, repair and disposal of falied componentes
Performance metric	Fill rate	Product availability
Inventory turns	6-50 per year	1-4 per year

Irregularities of demand can especially have implications for the supply chain performance. A common symptom is the bullwhip effect. The bullwhip effect is defined as demand fluctuations that aggregate in the supply chain, which causes unnecessary stockpiling (Bozarth and Handfield, 2016). It is caused by formulas such as the economic order quantity (EOQ) and re-

order point (ROP), which optimizes order size and inventory levels for a company. However, the formulas do not consider the whole supply chain, and when several companies use these formulas without communicating, it creates fluctuations in demand input. The bullwhip effect is harmful as it increases stockpiling, and therefore drives cost and causes stress on the supply chain.

Although there are tremendous benefits to be gained, many companies still struggle with the spare parts' business case. Companies, according to Wallin Blair et al. (2020) still hold on to the naïve belief that spare parts can be managed in the same way as direct material. Companies should treat spare parts with the appropriate resources and tools needed to reap the full potential benefits.

3.4.1 Traditional methods to manage inventory

Generally research on spare parts management has focused on inventory modelling (Jouni et al., 2011, Wallin Blair et al., 2020). As mentioned in Table 3.2, the inventory managements aim for spare parts is to pre-dispose resources. Bozarth and Handfield (2016) describes three main methods for inventory disposition. These are used to optimize the stock holding process along the supply chain.

EOQ
The EOQ is a method for managing the stock by calculating the optimal number of units in each order. The EOQ is affected by the holding cost, the order cost, and the demand. Using the EOQ is a starting point to understand the trade-off between inventory holding costs and order quantities. Ordering small batches increases the total order cost but allows for lower inventory levels. Bigger batches decrease the ordering cost but instead increases the holding cost. The relationship can be derived into the formula:

$$Q = \sqrt{\frac{2DS}{H}},$$

$$Where\ Q = order\ quantity, H = annual\ holding\ cost, D = annual\ demand, \\ S = ordering\ cost$$

An adaption of the formula is the EOQ period (EOQ POD) which gives the optimized number of days between orders:

$$EOQ\ POD = \frac{365}{D/Q}$$

ROP
The ROP is a method used to complement EOQ. The ROP system tells a purchaser when to send new orders. If there is a fixed demand rate (d) and lead time (L):

$$ROP = d * L$$

If there is a safety stock (SS), the formula is adapted to:

$$ROP = d * L + SS$$

The safety stock consists of units that are not forecasted to be sold. The products are kept only for emergency situations. The size of the safety stock is decided on a managerial level. A high safety stock reduces the risk of stockout, and it gives a high service level to the customers. However, it is a tradeoff as a too big safety stock leads to tied up capital and high warehousing costs that reduce the profit margins. As spare parts differ in the aspect of irregular demand, and the severe consequences of stockouts (Cohen et al., 2006), the safety stock is in this context especially important.

3.4.2 Control characteristics for spare parts

However, there are problems with traditional inventory management tools. Using general theory and models to manage inventory and flow for spare parts without considering their unique characteristics will likely not be successful (Jouni et al., 2011, Cohen et al., 2006). In Figure 3.4, different control characteristics and the corresponding system elements are mapped. Huiskonen (2001) suggests four criteria to categorized parts by to design the logistics system: network structure, material positioning, control responsibilities, and control principles. The control characteristics are further discussed in section 3.4.3. Companies that only look at one or two characteristics will rely too heavily on the one size fits all approach (Wagner and Lindemann, 2008).

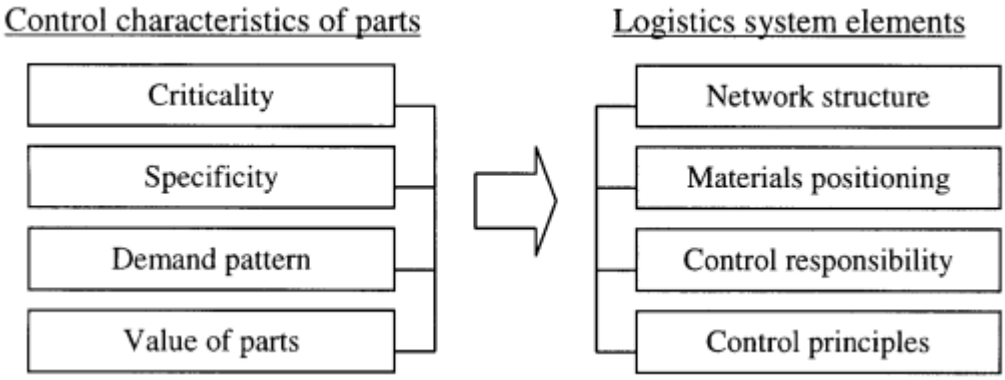

Figure 3.4. Control characteristics for spare parts and their corresponding logistics system (Huiskonen, 2001).

3.4.3 Classification of spare parts

In order for a company to distribute their resources in the best possible way, material groups should be treated according to their characteristics to create the appropriate logistics system (Huiskonen, 2001). As the number of materials for spare parts tends to be high, categorization can help create a manageable amount of product groups (Jouni et al., 2011).

The dominating method is the ABC classification, due to its ease of use (Huiskonen, 2001). The method is based on the Pareto principle, which assumes that 20 percent of the cause gives 80 percent of the outcome. In a classification context it translates into that a small group of materials accounts for a majority of the revenue (Teunter et al., 2010). The method works by dividing products into three categories, A, B, and C, where A is the most prioritized and C the least. The method can easily be extended to use more than three groups and factor in other

aspects than just cost. However, by including more product groups and multiple factors Teunter et al. (2010) argues that the method becomes complex and hard to use.

Huiskonen (2001) suggest a different approach, especially favorable for spare parts, where parts are classified by three criteria, which are presented in Figure 3.5. *Criticality* refers to the material's importance for the end customer, and it decides how agile the supply chain should be. *Specificity* is a measurement of the level of customization. A standard part will yield economies of scale in the ordering process, while it is harder to manage a part that is unique and ordered in smaller quantities. The *value* of the products is the final aspect. A high value means that it costs more to have it on stock and that inventory levels should be closely monitored. Instead, a lower price enables more stock keeping, and focus should be to keep down administrative costs. In Huiskonen's model these factors combined determine the design of the logistics network.

			Criticality	
			Low	High
Standard parts	Value	Low	• Order processing simplified e.g. by automated orders or • Outsourcing of inventory control to a supplier	• User's decentralized safety stocks and generous replenishment lot-sizes
		High	• Stock pushed back to the supplier	• Optimized user's safety stock (with high and smooth demand) • Time-guaranteed supplies from established service company (for lower and irregular demand) • Several users' co-operative stock pools (for very low demand)
User-specific parts			• User's own safety stock + partnership with local supplier to shorten leadtimes, to increase dependability and get priorities in emergency situations. • In the long run, standardization of parts when possible.	

Figure 3.5. Categorization of different parts with control strategies (Huiskonen, 2001).

3.4.4 Inventory placement options

As mentioned in 3.4.1, research on spare parts management has mostly focused on inventory modelling and demand patterns. However, to capture all aspects of spare parts management, the scope should be broadened. One area of particular interest regarding spare parts management is ownership of stock and inventory placement (Huiskonen, 2001). Wallin Blair et al. (2006) present a model for ownership of spare parts in the buyer-supplier dyad with four different ownership models, as seen in Figure 3.6.

		Inventory placement	
		At the buyer	**At the supplier**
Inventory ownership	Owned by buyer	*Inventory speculation* • Buyer pays for and physically holds inventory of a spare part before quantity and timing of demand are known Advantages: • Item on hand when needed • Protection against future price increases Disadvantages: • Inventory investment opportunity cost • Inventory storage, handling, and tracking expense • Inventory obsolescence expense	*Reverse consignment* • Buyer pays for inventory of a spare part before quantity and timing of demand are known but leaves the spare part in the physical possession of the supplier until needed Advantages: • Protection against future price increases • No inventory storage, handling, or tracking expense Disadvantages: • Inventory investment opportunity cost • Inventory obsolescence expense • Lead time for delivery
	Owned by supplier	*Forward consignment* • Buyer physically holds inventory of a spare part before quantity and timing of demand are known but does not pay for the inventory until it is used or sold Advantages: • Item on hand when needed • No inventory investment opportunity cost • No inventory obsolescence expense Disadvantages: • Subject to future price increases • Inventory storage, handling, and tracking expense	*Inventory postponement* • Buyer delays paying for, and physically holding, inventory of a spare part until quantity and time of demand are known Advantages: • No inventory obsolescence expense • No inventory investment opportunity cost • No inventory storage, handling, or tracking expense Disadvantages: • Lost production or sales when item is not available when needed • Subject to future price increases

Figure 3.6. Different combinations of ownership and inventory placement classifications (Wallin Blair et al., 2020).

Inventory speculation is the most common way of managing stock, where material is purchased before demand is known. It has the advantage of quickly covering unforeseen demand from the customer. When ordering larger volumes, it can render volume discounts and cheaper transportation per unit. The downside of this approach is tying up capital, and it leads to stock holding expenses.

The reverse consignment stock approach means that a company purchases stock which is then left at the supplier. The argument for using this method is to minimize stock holding costs and diminish the effect of price fluctuations. However, the drawbacks are costs due to capital expenditure and obsolete stock.

With forward consignment, the buyer holds stock at their facility, while ownership stays with the supplier. The purchase is first made when the material is used in production. With this solution, the capital expenditure decreases, and the risk of obsolete stock disappears. However, the warehousing cost does not decrease. The solution also creates administrative issues, as it is complex to track material to determine the transition of ownership.

Inventory postponement is the opposite of speculation, where the material is first purchased when the demand is known. The method diminishes the risk of obsolete stock, decreases tied-up capital and warehouse cost. However, the drawbacks of the solution are long lead times, lost sales because orders cannot be fulfilled, and problems with minimum order quantities (MOQ).

To determine which storage solution that fits different products the best, there are three criteria proposed by Wallin Blair et al. (2020), similar to the control characteristics introduced in section 3.4.2. They propose to position the stock after uncertainty, usage rate and item specificity, see Table 3.3.

Table 3.3. The recommended action for the stock placement depending on the level of uncertainty, usage rate and item specificity, adapted from Wallin Blair et al. (2020).

	Low	High
Uncertainty	Internalize	Externalize
Usage rate	Externalize	Internalize
Item specificity	Externalize	Internalize

Different product characteristics leads to different inventory placements. Units with high specificity, and low uncertainty that are ordered often should be kept in stock, while other material should be kept at the suppliers.

3.4.5 Consignment stock strategy

Especially the popularity of one form of stock ownership, called consignment stock, has increased (Zavanella and Zanoni, 2009). The strategy has similarities with the case company, as the model enables companies to commit to stock at a supplier and share the production risk. It is therefore a valuable aspect to investigate further.

Battini et al. (2010) propose a framework for the consignment stock strategy, which consists of ten separate steps. Key steps are partner choice, material selection, data exchange infrastructure, and definition of stock levels. Valentin and Zavanella (2003) analyzed examples from the industrial practice of the consignment stock strategy which attributed to several learnings. An agreement is signed between the vendor and buyer to administer the policy, which is an important aspect to control. The agreement stipulates several features such as payment terms, fixed lead times, and stock-level at the vendor's warehouse. It can also include a risk-sharing solution, which means that for materials included in the scope of the policy that are not purchased, the buyer still agrees to pay for the goods. A key step to be successful is communication. It could be set up fairly easy for example as a Kanban system. The importance, however, is to be able to track daily consumption.

Regarding material Valentini and Zavanella (2003) argue that the material included in the consignment stock should be characterized by constant consumption, and not be too non-standardized, e.g., prototypes and new product introductions. Wallin Blair et al. (2020) instead argues that material with low usage rate should be externalized. Battini et al. (2010) take the side of Valentini and Zavanella (2003), in which materials with stable and high annual consumption are suitable for a consignment stock strategy but argues that benefits can also be found in situations with variable demand and obsolescence risk. Further, they mean that materials the most suited are low-value items with ease of storage.

Another key area of the consignment stock policy is inventory levels that the suppliers are to hold. Wagner and Lindemann (2008) describe the trade-off regarding stock-levels. High stock levels result in high availability, but also tied-up capital, stock-keeping costs, and scrapping risk. On the other hand, low stock levels lead to the risk of lost sales and decreased customer service but keeps costs down. Unsuccessfully finding the balance between the two could damage the profitability of the spare parts business. For the consignment stock case, there is no standard method, and the application varies across companies. Battini et al. (2010) argues that

it is mainly based on the forecast, and due to differences between companies, it should be decided from case to case.

The consignment stock policy has advantages both for the seller and buyer (Battini et al., 2010). The buyer will receive a reduced holding cost as there is less material in the warehouse. Material will be paid for first when used, and as a result, the capital tied will decrease. There are also several advantages for the vendor as there is precise information on what needs to be on stock, the average stock decreases. The seller can also receive increased flexibility and adapt its production to get optimized production lot sizes. The benefits are summarized in Table 3.4.

Table 3.4. The benefits for the different parties with the consignment stock policy (Battini et al., 2010).

Benefits for the buyer	Benefits for the seller
Material on-hand	Optimization of transport
Reduced management cost	Optimized production lot sizes
Lead times drastically reduced or eliminated	Information sharing regarding the buyers' consumption
More flexible production mix	Long term relationship commitment
Postponment of payment until material is used	Vendors can stock according to assigned levels which helps them to have more space available

Zavanella and Zanoni (2009) describe two main problems with the consignment stock strategy. Firstly, the benefits are more significant to the buying company. It is especially present when a large company buys from a low to medium sized company. Second, the advantages are less apparent when the consignment stock strategy covers products that the supplier regularly sells to several customers. When demand is split between several customers the risk of manufacturing decreases. Then benefits become less apparent, and the consignment stock only becomes another area to administer. Especially the second issue is common for situations where parts and component suppliers deliver to assembly companies. Gharaei et al. (2019) argues for another central issue of the consignment strategy: deciding stock levels for the suppliers to hold in ready-made stock. The figure can be calculated mathematically based on service level by the buyer. Although, it is generally done by the supplier, as it requires vendor-specific information. Overall, can it be essential to find an optimized number of ready-made stock for finding success with the method.

3.5 Supplier collaboration

As the strategic importance of purchasing has increased, so has the role of the suppliers, who now affect the long-term competitive position of the firm (Van Weele, 2014). Prajago and Olhager (2012) argues that strategic supplier management has both an indirect and direct impact on a company's performance. Companies have realized that their own profitability are greatly affected by the supplier's performance, and that there is an opportunity to capitalize the relationship.

3.5.1 Motives and gains from supplier collaboration

There are different motives and gains for entering a supplier collaboration. Johnson and Houston (2000) discusses four motives and gains in joint ventures and partnerships.

Synergy sharing is the first aspect that is mentioned. Close collaboration enables economy of scales, lower inventory levels by information sharing and shared resource control, and more efficient production. According to Johnson and Houston these gains are mainly present in horizontal collaboration and less so in vertical.

The second reason for a partnership that Johnson and Houston discuss is the governance of uncertain transactions. In most buyer-seller relationships the power balance will change over time. In a buyers' market, the suppliers make asset-specific investments to fulfil orders and are required to hold risk until a deal is done. It leads to a weak negotiating position for contract renewals regarding quantity, price, and delivery terms. If it instead is a sellers' market, the buyer can create hold-up hazards by demanding similar concessions but of the buyer. This kind of risk is generally present when there are uncertain demand and high up-front investment costs.

The third aspect of partnerships is to enable investments with uncertainty. The buyer generally has a comprehensive understanding of the situation regarding the current demand and future growth. If the supplier needs to invest in capital-intensive equipment, the buyer can assist by settling favorable terms as the development is mutually beneficial.

The final aspect that Johnson and Houston discuss is risk-sharing. To enter a market through a partnership by contract or through a joint venture is an enabler for efficient risk-sharing. Cooperation is mutually beneficial; the supplier is sure to sell products manufactured and the buyer ties up less capital to fill an order, enabling taking more orders and utilizing capital more efficiently. It is especially beneficial in a market with uncertain demand and where the supplier base is less diversified.

If a manufacturing company and its supplier manage to align their interests and create a supplier buyer alliance, positive gains for both companies can be realized. Nyaga et al. (2010) supports this idea, stating that collaborative activities lead to trust and commitment between the supply chain participants, which in turn lead to improved satisfaction and performance. Further, a study of 100 large organizations showed that companies that regularly collaborated with suppliers demonstrated higher growth, lower operating costs, and greater profitability than their industry peers (Gutierrez et al., 2020).

3.5.2 The supplier-partnering hierarchy

As companies realize the potential gain of suppler collaboration, there has evolved several methods of supplier collaboration. For the case company, it is relevant both to determine how to cooperate with suppliers and which suppliers it is feasible to develop the relationship with. The Japanese auto manufacturers Toyota and Honda have been considered the archetype of successful supplier collaboration for the last 25 years (Van Weele, 2014). To develop their supplier relationships, the two companies have followed six golden rules (Liker and Choi, 2004):

1. *Understand how the supplier work* - It will lay the foundation for powerful collaboration as there is a mutual understanding.
2. *Turn supplier rivalry into opportunity* - Instead of challenging the supplier base for the lowest price, the Japanese car manufacturers see it as an opportunity to improve current relationships. Giving new contracts to suppliers that have previously performed well enables mutual growth and deepens relationships.
3. *Careful monitoring of the supplier's performance* -The supplier's performance is too important not to monitor, and potential errors should be followed-up immediately. Working with scorecards of the supplier's performance can be an excellent way to track the progress over time.
4. *Develop technical capabilities* - To get the supplier to work in a way compatible with the buying company, there is a need for technical capability. It involves understanding terminology and using the same units and parameters for measurements.
5. *Intense but selective information sharing* - Instead of having unstructured meetings where the supplier is inundated in data, the Japanese manufacturers have deliberate agendas for information sharing. The information shared is explicitly selected for the supplier to ensure they have all the relevant data when needed.
6. *Conduct joint improvement activities* - While many companies have joint improvement sessions, the Japanese car manufacturers have taken it to a new level. They have 13 weeks of joint projects for new suppliers, and they have engineers stationed working with improvement projects stationed at the supplier's plant. It enables their supplier to adapt to their own processes, as well as improving the supplier’s performance.

Liker and Choi (2004) have compiled the rules to create the supplier-partnering hierarchy, see Figure 3.7. The purpose of the pyramid is to underline that rules cannot be partly followed. The steps are interconnected, delivering in one area is an enabler to improve elsewhere.

Figure 3.7. The supplier-partnering hierarchy, showing different steps to become successful with supplier cooperation (Liker and Choi, 2004).

3.5.3 Risk-sharing partnerships

The rise of global markets and thus global competition has forced todays supply chains to improve their supply chain risk practices (Ghadge et al., 2017, Buzacott and Peng, 2012). Globalization have enabled supply chains to source globally to get the best possible quality and price. However, it is achieved at the cost of decreasing the supply chain resilience, meaning that disruptions happen more frequently with severe implications (Van Hoek, 2020). To countermeasure it there has, according to Ghadge et al. (2017), been an increase in contractual agreements with risk-sharing solutions. The two main causes for initiating risk-sharing solutions are to manage irregular demand and fluctuating prices. The benefits of contractual risk-sharing are especially present in industries where it is not possible to diversify the suppliers, as it renders high overheads and removes economies of scale (Buzacott and Peng, 2012). Selviaridis and Norrman (2015) have evaluated some of the difficulties in performance-based contracting. It is difficult to determine fair KPIs for evaluation of the partnership. If mutual incentives cannot be achieved, it will hinder successful implementation. Setting up often complex infrastructure to facilitate the cooperation is associated with extensive costs.

3.6 A conceptual model for analyzing buyer-supplier agreements overseeing purchasing cooperation

The literature analysis can be summarized in Figure 3.8. The model consists of three different areas important to evaluate for a buyer-supplier agreement; (i) looks to answer what materials that should be included in the agreement and how they should be handled through the cooperation; (ii) asks the question of who should receive the agreement; (iii) ponders the question of why the agreement should be in use and what is it supposed to achieve. Across all three pillars, it is pertinent to have strategic alignment, process integration, and cost optimization in mind so that the answers to (i), (ii) and (iii) will not conflict with each other, and to avoid suboptimization. This model will be used to conduct the analysis in chapter 5.

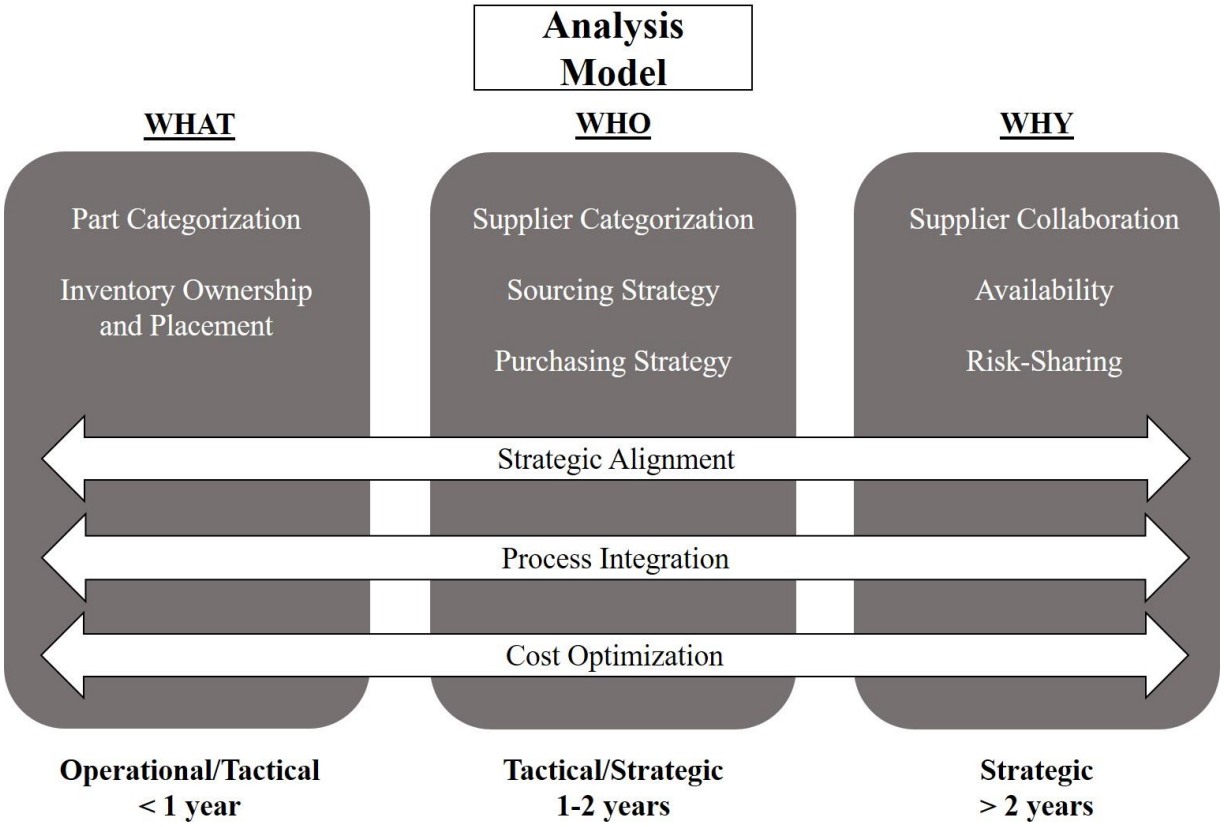

Figure 3.8. A conceptual model for analyzing purchasing cooperation in a spare parts context.

4 Empirical Data

This chapter will present the empirical data that has been gathered during the research. It will begin with a description of the case company's organization and processes, before venturing into the logistics agreement and its effects. Some data has been scaled or omitted, due to confidentiality reasons. The data will be both of qualitative and quantitative nature and will mainly focus on the historical values from August 2020 through January 2021. Included in this chapter is also comparative data from other companies, which is presented in the final section.

4.1 Tetra Pak's after-sales purchasing

The after-sales is high on the agenda at Tetra Pak. It receives a lot of attention from top management, and improvements are continuously employed. Purchasing for the after-sales is highly prioritized, as a main challenge is to supply the customers with relevant material in the shortest time possible. To achieve it TPTS works close with their suppliers to find the best-in-class solutions.

4.1.1 Organizational setup

In order to offer after-sales at a level requested by customers, Tetra Pak has created the Technical Service organization (TPTS) that are responsible for the after-sales (as shown in Figure 1.1). The purchasing organization for the after-sales is managed by PSC. In the past all purchasing for Tetra Pak was done centrally, but the unique nature of spare parts motivated a separation. Now purchasing for spare parts are done separately, managed by a central team in Lund. The exception is China, where a separate unit is responsible for handling suppliers in the region. The Chinese DC is handled as a supplier from which the Lund DC purchases spare parts directly from.

TPTS works with after-sales for Tetra Pak's business units, of which there are two main business areas: *Packaging Solutions & Commercial Operations* and *Processing Solutions & Equipment* (Tetra Pak, 2021). The packaging business unit has long been part of the core product offering and has a high level of process integration with TPTS. The processing business unit has been an autonomous division with less process integration with TPTS. For example, different classifications have been used to determine a materials criticality, and also since the processing unit has no bill of material, less data is available regarding the installed product base for those machines. However, recent efforts have been made to align the business units in terms of processes and long-term goals, labeled as the "One Company" goal.

4.1.2 Market characteristics

The variety of parts needed to service the packaging and processing equipment is considerable. Especially customers with several machines active generally request a one-stop-shop for maintenance and spare parts, although there are exceptions. Especially in case of breakdowns, the customers value quick response over price. In the food industry, a processing and packaging machine's role is both to process and protect the product. Downtime for the machines can cause

delays that can make the product's quality decrease to an extent where it has to be discarded. The severe consequences of breakdowns make the customer's request excellent after-sales service, for which they are prepared to pay a premium.

For Tetra Pak, customer service is one of the main competitive advantages. The after-sales drive overall customer satisfaction and are a factor in new purchases. Traditionally Tetra Pak has been active in the after-sales market, but the importance of the function has increased over time. As a part of their after-sales strategy, Tetra Pak has stipulated a high service level, with a promise to offer after-sales for all equipment ever sold. The task is challenging since the company has sold processing and packaging solutions since the 1950s and currently has almost 100.000 machines running (Tetra Pak, 2021). The complexity of offering after-sales has also increased over time. The number of machine generations active in the market increase over time and global sourcing to achieve a low price has created longer lead times and a more complex supply chain.

4.1.3 Purchasing process

The Supplier Manager is the main responsible entity for managing the suppliers, involving contract negotiations, communications, and improvement efforts. The Supplier Managers are not exclusive to the TPTS organization as they manage suppliers that deliver to both the production and the after-sales. When negotiating agreements with suppliers, different factors determine the terms. For the suppliers, the MOQ renders security that orders will fit their production batches. Therefore, a high MOQ will render a more competitive price. There are also scaled prices negotiated, which means that as the quantity ordered increases, the price per unit decreases. After the contract is negotiated, the replenishment unit handles the operative purchasing. The unit responsible for setting stock levels and managing what is purchased is the stock management group. The Supply Chain Analyst's role is to link the purchasing with the suppliers in cooperation with the Supplier Managers. The Global Planning Expert works with internal stock levels, and the Customer Stock Analyst is responsible for managing the customers' stock.

Several factors decide stock levels and purchasing at TPTS. Generally, the EOQ POD together with the ROP triggers straight rebuys of standard equipment, and decides the stock level at the warehouse. It is automatically calculated by their ERP system, based on the lead time of the material and the demand, that is calculated from the procurement forecast. When the lead time changes, the system will update the stock levels. Beyond that will material critical for the customer be kept in safety stocks, even though there is no current demand. It is done to prevent stockouts, and in the end, downtime for the customers' equipment. As there is no demand for these materials, the system calculates the stock level to zero. To overcome that, the customer stock analyst overrides the system formula and manually enters a new stock level. To map costs internally, the internal stock keeping interest at Tetra Pak is 30 percent per year spent in the warehouse.

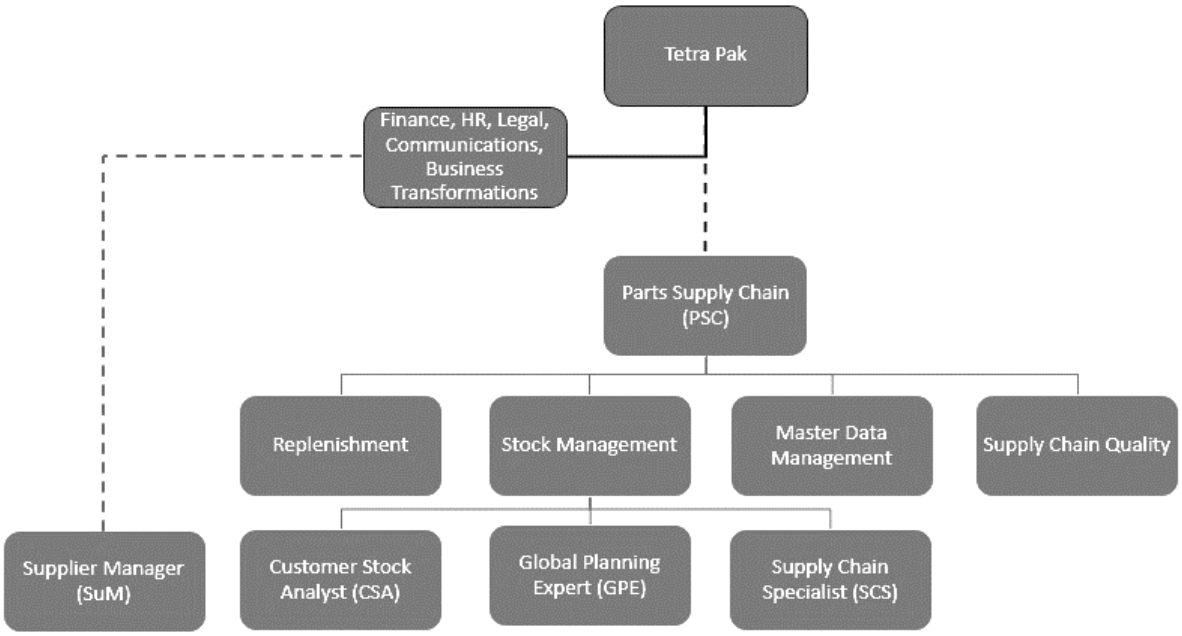

Figure 4.1. Organizational chart of divisions overseeing the purchasing process of spare parts at Tetra Pak.

4.1.4 Categorization of materials

Tetra Pak categorizes their spare part materials, which is necessary to oversee the operations. From a sourcing perspective, the materials are divided into OEM, Drawn, and Consumables. OEM means that Tetra Pak purchases a material that has been designed and produced externally. For Drawn materials, Tetra Pak has designed the material and owns the product design but outsources manufacturing. Lastly, Consumables encompasses materials, such as glue and lubricants.

For the handling and purchasing of spare parts, another categorization is used. Firstly, the materials are either active or non-active. Active materials have to either been bought at least once the last two years, have an open sales order, or currently be in stock. Consequentially, non-active materials are spare parts that do not fulfill any of the three criteria but may still be bought in the future as at least one machine still uses them. Presently there are over 500.000 non-active materials and about 140.000 active materials. The active materials are shown in Figure 4.2, and can be further categorized.

- ASL – A material that fulfils the criteria set out in Figure 4.4, which is mostly based on the forecasted procurement need of the material. These are the high-runner materials that are frequently ordered.

- LA – A material that is an ASL material, but the supplier of the material has signed a logistics agreement with PSC.

- TPMS – A material part of a machine, that at some point during the machine's lifetime has to be switched out. Often seen as maintenance material.

There are some overlap between the three categories, as a material can fulfil multiple of the definitions. Therefore, a more exclusive definition can be used in order to see how large part of

active materials the categories constitute. The definitions are *ASL with LA*, *ASL non LA* (ASL materials without a LA), and *TPMS non ASL* (TPMS materials that does not fulfil the ASL criteria). Materials that are neither of these three categories, but is still an active material, are shown as *Other material* in Figure 4.2.

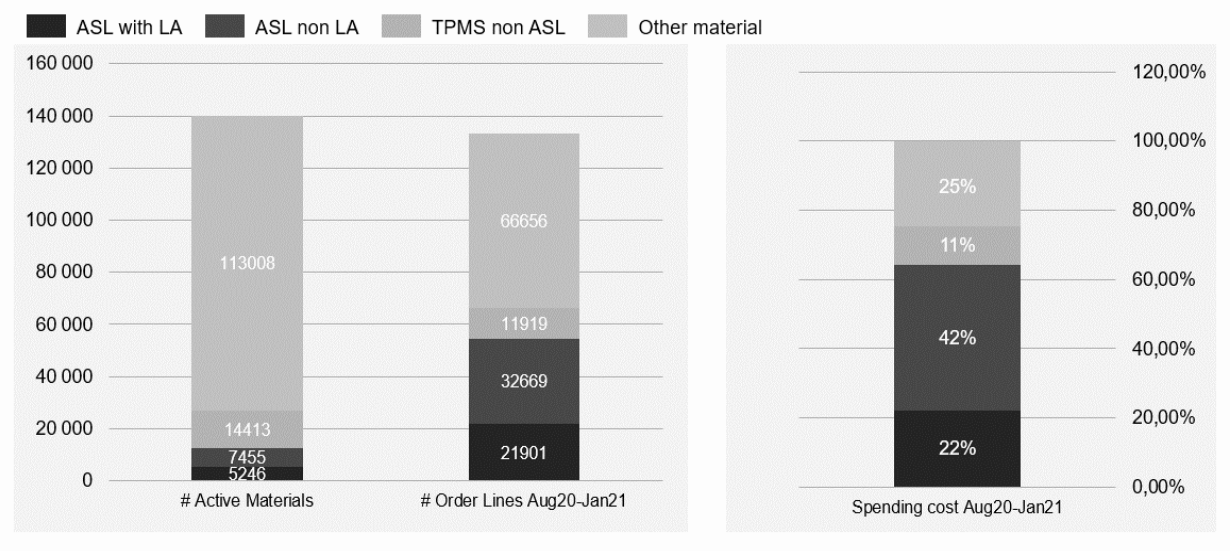

Figure 4.2. The distribution of different materials groups in terms of number of active materials, number of order lines, and spending cost.

There are also other categorizations in addition to the ones shown above. Tetra Pak categorizes parts in terms of criticality to both the process, and to the end customer. These are subjective categorizations, often done by the original designer of the material or the machine it is used in. Currently none of all the categorizations except for ASL and LA are used in the logistics agreement.

4.1.5 Limitations on sourcing flexibility

TPTS deploys several sourcing strategies when choosing suppliers, but there are some limitations of how flexible they can be with finding new suppliers. As the main company, Tetra Pak, is active in the food industry it entails scrutinous reviews. The demands are especially specific for material in contact with foodstuff before or after processing. Tetra Pak's customers must show that their products have been manufactured in a safe way for the final consumers. As a result, it is pertinent for Tetra Pak to certify that all material used in their equipment fulfills the safety standards for food production. Going further upstream it means that all Tetra Pak suppliers have to apply for certification to produce material in contact with food or used in food production. The process is long-drawn, expensive, and requires administrative work as the supplier must first produce an approved sample before they are approved. The approval can, depending on the material, take several months. The consequence is that it is expensive and time-consuming to re-source material, especially the materials in contact with food. The sourcing strategy is therefore generally that materials in direct contact with food are single-sourced. The use of several suppliers for one set of materials needs administrative work, and as the volumes ordered generally are low, the net benefit is marginal. A safety stock is kept to overcome the risks associated with using a single supplier.

4.2 Buyer-supplier agreements

A strong emphasis exists within Tetra Pak, and especially PSC, to work closely to their supplier and collaborate in order to achieve the best possible performance. There are examples of having joint workshops with suppliers, sharing forecasted sales data with the suppliers, and reviewing performance together on a frequent basis. While the whole Tetra Pak organization signs general purchasing agreements with suppliers through the Supplier Management division of the company, PSC sometimes offer an additional agreement. That agreement, the logistics agreement, sets out to increase the risk-sharing and collaboration between PSC and the supplier, in order to achieve certain targets. This section will describe the current process of the LA, how the scope is defined, which areas that are included in the agreement, and the results of the agreement.

4.2.1 Driving forces behind the LA

Due to the nature of spare parts and the market characteristics of after-sales service, availability is at the core for what PSC is trying to achieve. One way to ensure high availability of spare parts to PSC customers is to have high levels of safety stock of all materials. This is an expensive and possibly infeasible solution. Instead, PSC uses some safety stock and then orders more materials from their suppliers when necessary, which is calculated from sales forecasts and current stock. Materials that the calculation says will frequently have to be ordered, PSC has categorized as ASL materials, which is mentioned in 4.1.4. The idea is to shorten the lead time for these materials, to enable lower stock levels, with maintained availability.

For ASL material, PSC wants to have 14 days lead time and 96 percent delivery performance from the supplier. If the supplier struggles to achieve it, PSC suggests for the supplier to build up a finished goods inventory of the material. PSC labels the materials ASL as it stands for Approved Stock Level, which mean the levels of stock the supplier is recommended to build up. A supplier that does not want to take on the financial risk of building up a finished good inventory of ASL materials can be offered a LA. The terms in short for the LA are: The supplier should for all ASL material they manufacture keep three months forecasted material in finished goods inventory. The forecasted levels of ASL are shared monthly with the suppliers. In return, Tetra Pak agrees to take on the financial risk for the produced material. If Tetra Pak stops purchasing the material, or buys less than the shared ASL, they agree to buy out the ASL stock that the suppliers have kept. It is only applied as long as the supplier achieve 14 days lead time for the material and has a 96 percent overall delivery performance, described further in 4.2.5. Tetra Pak's current overall goal of the LA is to increase availability to the end customer, and to achieve it there are three different focus areas (Figure 4.3).

Secure delivery of spare parts from suppliers	Financial risk sharing between suppliers and Tetra Pak	Close supplier cooperation through information sharing
▪ Short lead times (LT) especially for high runner items which is connected to Approved Stock Levels (ASL) ▪ Improve and secure overall delivery performance (DP) of the supplier	▪ Enable suppliers to deliver on targeted delivery levels. Achvied by sharing the financial risk of building up stocks ▪ Tetra Pak takes on financial risk by giving warranty of buying out 3 months sales forecast of ASL-material, given that the agreement is followed	▪ Suppliers are be able to plan production better and hopefully be more flexible in accostuming TPTS needs ▪ Avoid slow responses to customer requests, as late deliveries can have 10-fold effect for TPTS customers which can decrease customer satisfaction and impair future sales

Figure 4.3. Three different purposes of the LA, with the end goal of having high availability to the after-sales customers.

The decision process for offering LAs to suppliers is handled by the Supply Chain Specialist in cooperation with the Supplier Manager. However, the final say is always given to the Supply Chain Specialist. The deciding factors in the current decision process are not formalized, but two factors are considered: the supplier's current performance in terms of delivery performance and lead time and the number of ASL materials sourced to the supplier. Of the over 450 suppliers that produce at least one ASL material, only 65 has currently signed a LA with PSC.

4.2.2 Evaluation criteria for becoming an ASL material

The materials that are included in the ASL, and as a result the LA, is decided by several criteria. The process starts with forecasting. The sales forecast covers future sales and is generated by the product owners and the new product introduction team. The sales forecast is converted into a procurement forecast, which specifies the purchasing needs to fulfill the expected sales. The overseeing department is the Global Planning Experts. From the procurement forecast the EOQ POD and the list of ASL materials are then generated.

There are several criteria a material has to fulfill to be classified as ASL, see Figure 4.4. The material has to be classified as either stock locked (SL), indicating it is a new material, stock new (SN) for material with a manual forecast, and stocked (ST) which means that it should be in stock. The material forecast must exceed zero, and it has to be purchased at least monthly. There cannot be more than six months supply in stock, and the EOQ POD must be between 10 and 50 days.

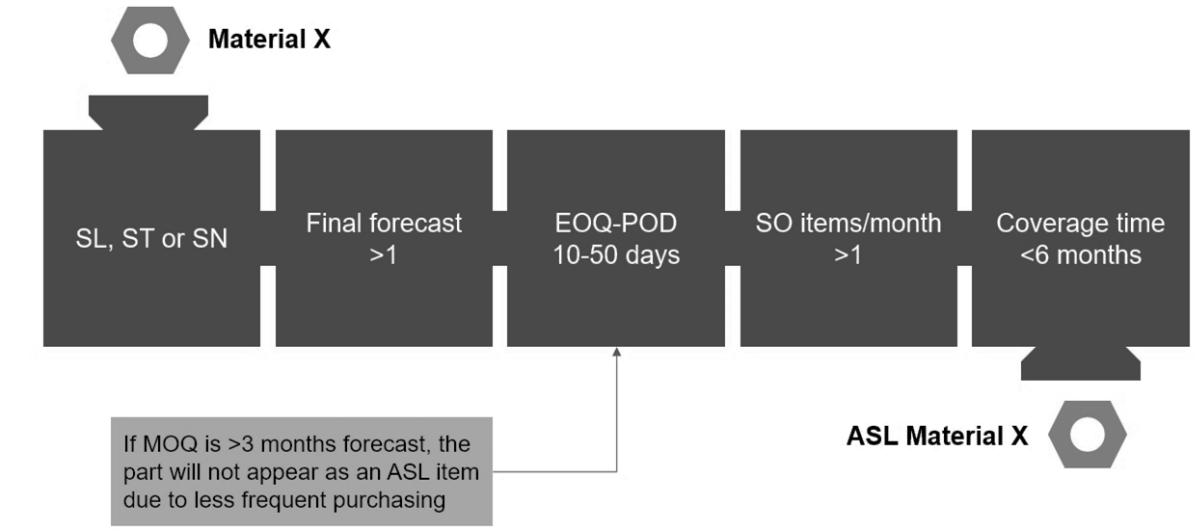

Figure 4.4. The five criteria a material has to fulfil to be classified as an ASL material.

However, after going through all materials there is another factor affecting the ASL scope, which is the MOQ. The MOQ is negotiated by the Supplier Manager, and generally can a higher MOQ render a more competitive unit price. If the MOQ is higher than the EOQ, the EOQ will be increased to equal the MOQ. If the MOQ is higher than three months forecast the material will be excluded from the ASL scope (Figure 4.4). An analysis of the MOQ and EOQ in the ASL scope shows that the MOQ is a deciding factor for 15 percent of ASL materials (Figure 4.5).

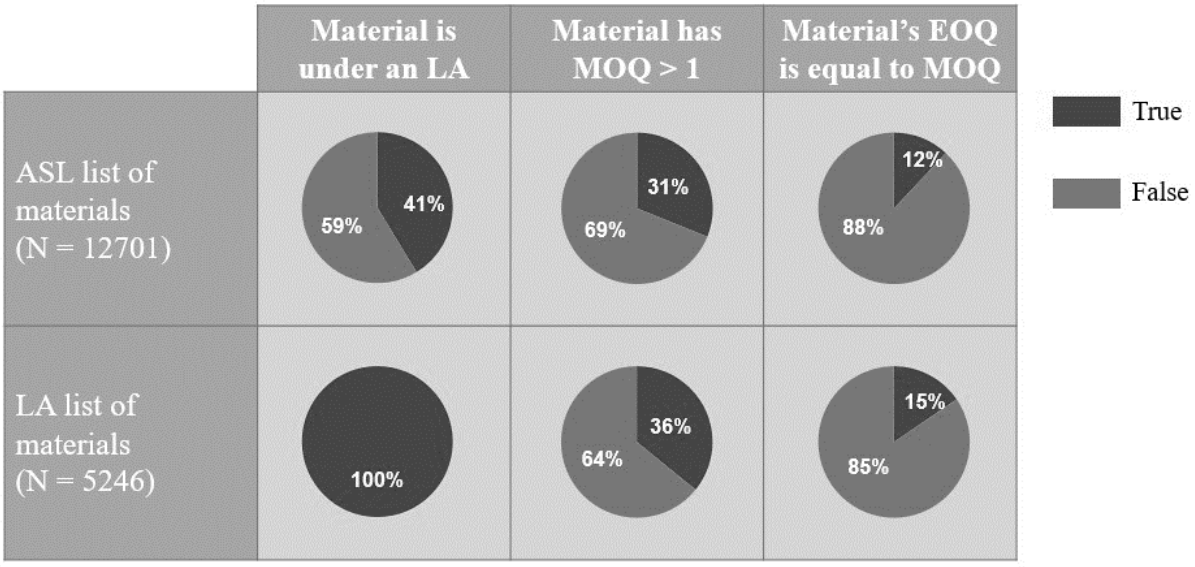

Figure 4.5. Graphs regarding the influence the MOQ has for the EOQ of ASL and LA materials.

4.2.3 Follow-up of overordering and supplier delivery performance

The terms of the agreement are that suppliers have three months forecasted stock available at 14 days lead time. However, if Tetra Pak orders more than the forecasted stock, the suppliers will not have enough stock to cover the orders and cannot be expected to deliver in 14 days. If that has been the case, corrections are made to ensure that the delivery performance reflects the

actual performance. The process of corrections starts with the Supply Chain Analyst each month manually checking with a template the actual orders versus the forecasted. If there has been over-ordering, registered delays for the period are removed. Overordering is defined as either ordering more than 100 percent of the three-month ASL for the material in one month, or more than 133 percent of the forecasted three-month ASL over three months. The monthly process is shown in Figure 4.6. The process is described by employees as tedious and time consuming, which is made more difficult by the fact that there is no automated way to track the actual LT for the ordered material.

4.2.4 Process of updating the list of ASL materials

As seen in the previous section a material must fulfil certain criteria to be an ASL material, and how a material perform against those criteria is not static over time. PSC has therefore a process for updating the list of materials that are assigned as ASL. The process consists of two updates, one monthly and one bi-annual. The ERP updates the scope and criteria scoring continuously, and materials that at the first day of each month fulfils the criteria in 4.2.2 are added to the ASL list. In this update, materials can only be added to the ASL list. There are some exceptions though, for example if the material does not have sourcing that month due to change of supplier. In those cases, the material is back on the list as soon as it has a new supplier. However, a material can only actually be removed from the ASL list at the bi-annual update. This update occurs in February and August each year and is the occasion where the system excludes material that no longer fulfils the ASL criteria. A timeline for the update processes is shown below in Figure 4.6.

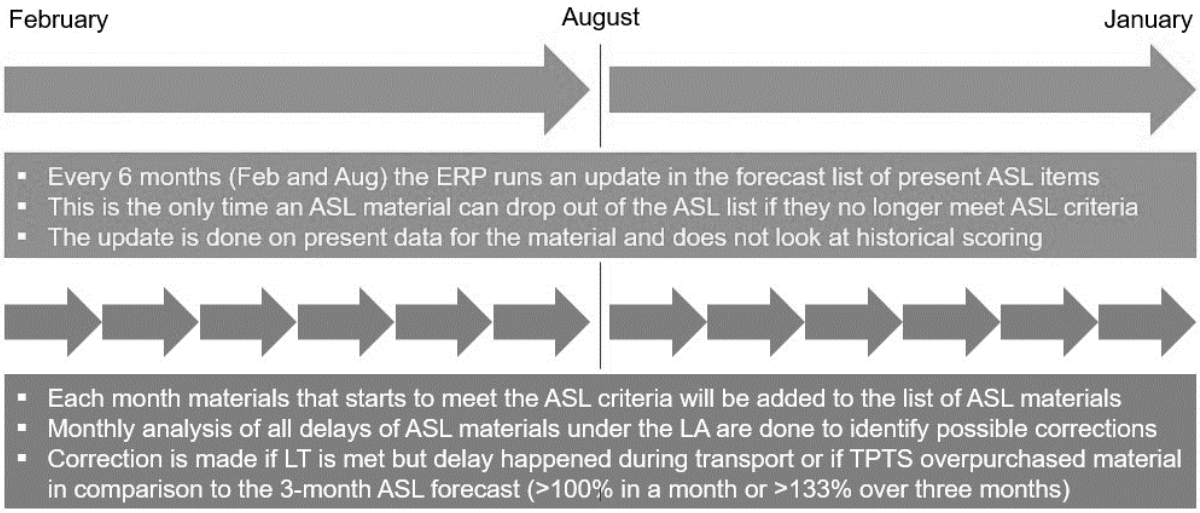

Figure 4.6. Description of the timeline for the processes of updating the ASL list as well as the monthly process of corrections as described in 4.2.3.

The updating process leads to that about 3000 materials are added over six months. Then in February or August, about the same number of materials are removed (Figure 4.7). The main reason for the turnover is either that the sales forecast has turned to zero, or that the EOQ POD changes outside the interval. The turnover of materials in the ASL scope has the effect that it is hard to know which materials that are included in the LA. When a material is marked as ASL and the supplier has signed the LA, the supplier has three months to build up stock. During the ramp up phase the supplier has no obligation to deliver according to the shorter lead time and

delivery performance stipulated in the LA. Due to the vast number of materials, it is sometimes hard for PSC to track the compliance among the ASL materials.

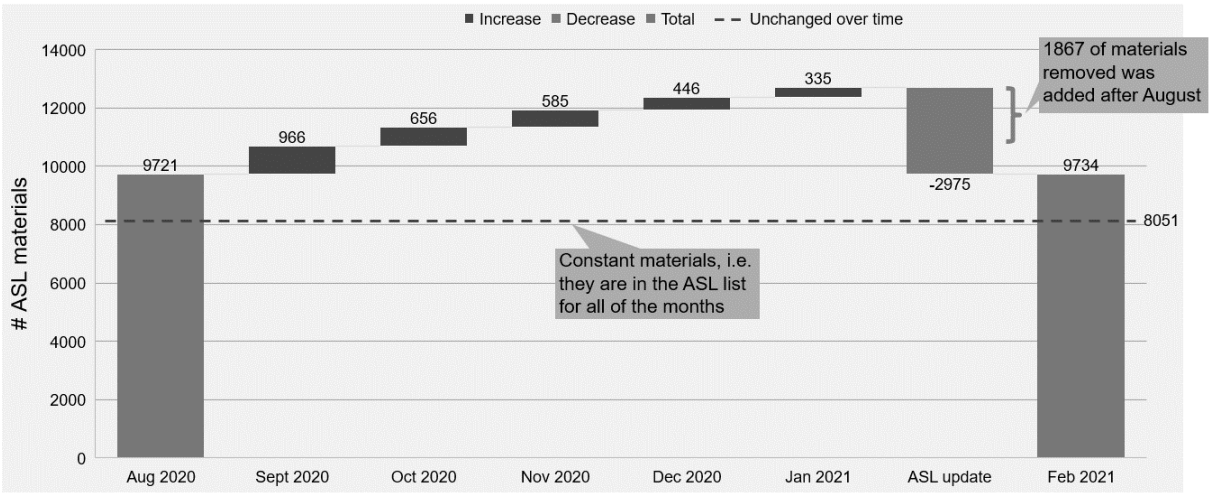

Figure 4.7. The number of ASL materials between August 2020 until February 2021.

4.2.5 Financial settlements

Financial settlements, or buy-outs as they are also called, is a substantial part of the current logistics agreement. It is the claim that suppliers are granted in exchange for keeping stock. There are three reasons why a supplier can request a buy-out from Tetra Pak: Removal due to engineering changes, a material is replaced or resourced, and material are excluded from the ASL because the purchasing forecast turns to zero. The process is explained in Figure 4.8.

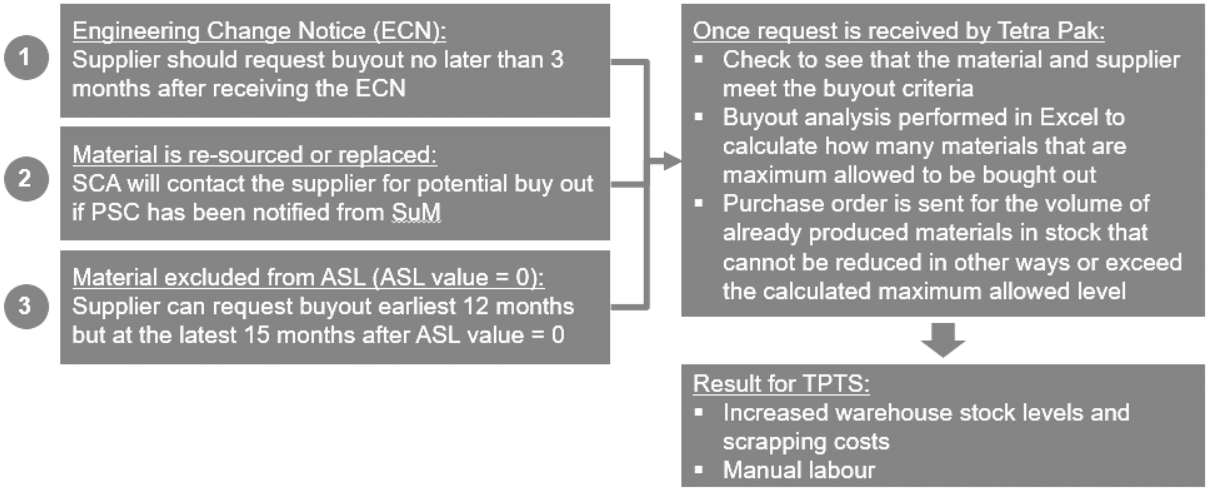

Figure 4.8. Three reasons why a buy-out can happen, the process after a request has been sent and the consequences for TPTS.

For Tetra Pak to accept a buy-out request, there are three criteria that has to be fulfilled (Figure 4.9). First the supplier must have signed the LA. Second the material for which the buy-out is requested, must fulfil the ASL criteria. Finally, the supplier must achieve a total score of 96 percent delivery performance and have an agreed lead time of 14 days for the material. However, it is not currently validated if the material is actually delivered in 14 days. This lack

of compliance also shows itself in that only 59,4 percent of all materials under an LA has an agreed LT of 14 days.

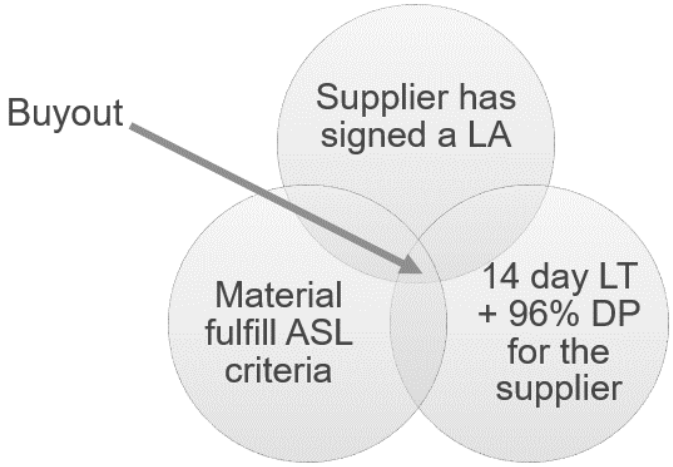

Figure 4.9. Three criteria for a material that needs to be satisfied for a buy-out to happen.

4.2.6 Summarization of the process

The full process of the logistics agreement can be summarized into Figure 4.10. There are six different steps, and the follow up step goes back into the ASL to compare the volume ordered versus the volume forecasted.

	Characteristics	Overseeing Dept.
Sales forecast	▪ Future estimated sales of spare parts ▪ Not disclosed with suppliers	▪ CSA, GPE, (Product Owners, Introduction)
Procurement forecast	▪ Forecast built on the sales forecast ▪ EOQ, MOQ, ASL	▪ GPE
ASL	▪ Level supplier built stock to ensure availability ▪ Has multiple criteria (see Figure 4.4)	▪ SCS
LA	▪ For suppliers that need/want warranty to build up ASL	▪ SuM, PSC, suppliers
Order & delivery	▪ <= 14 days LT for material ▪ >= 96% overall DP for supplier	▪ Replenishment, SuM, warehouse, suppliers
Follow up	▪ Corrections due to order above ASL, slow transport, buyout etc.	▪ SCS, SuM, suppliers

Figure 4.10. Summarization of the logistics agreement process.

4.2.7 Effect of the LA

In order to see the performance of different material groups, the effect of ASL compared to other materials were mapped, see Figure 4.11. In the graph there is a distinct over-performance for ASL material with LA compared to other material groups. The same analysis was also done with different filters to see the performance for forecasted material, material bought on

customer request. The results for all datasets were clear; the delivery performance for materials included in the LA scope was substantially higher.

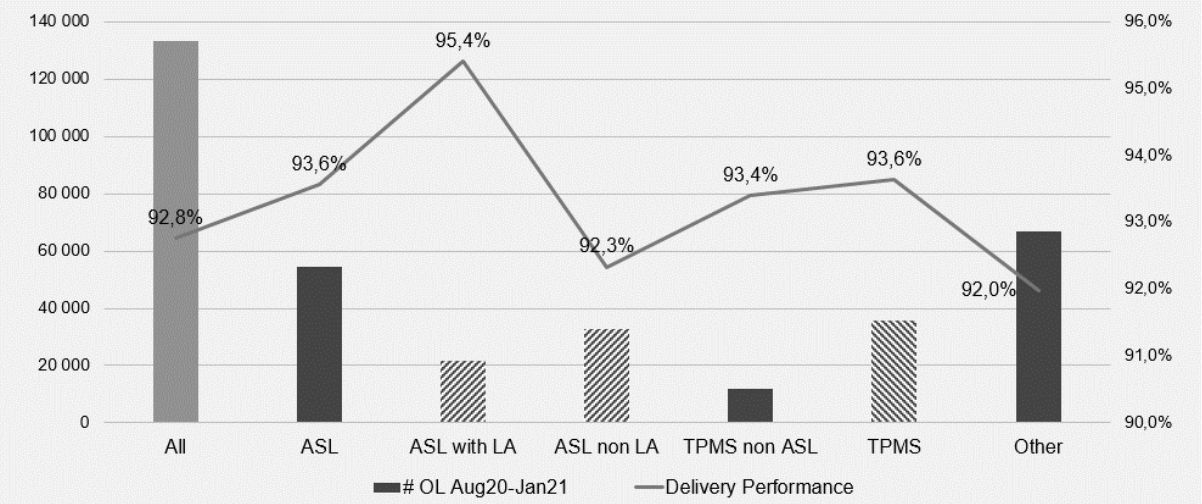

Figure 4.11. Delivery performance for different material groups.

For materials that are included in the ASL and covered by a LA, TPTS make a commitment. Figure 4.12 shows the capital covered by the LA process at different levels. To map how much of capital covered that is actually bought out, all buy-outs from August 2020 to January 2021 that could be directly linked to the LA are included. The actual buy-outs come from situations were there the expenditure clearly are linked to the logistics agreement. Numbers are scaled due to confidentiality reasons.

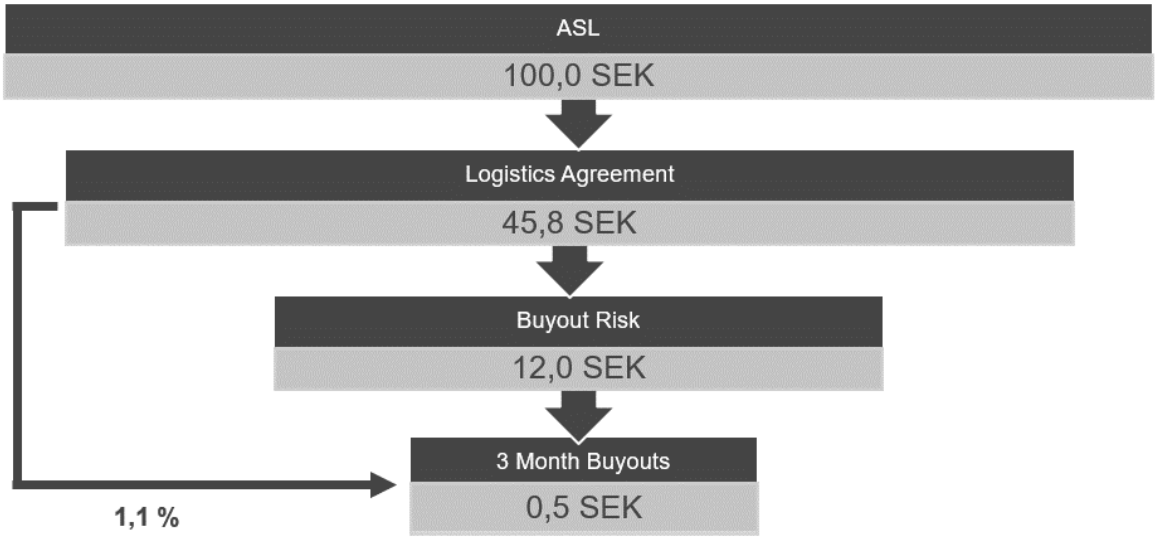

Figure 4.12. Capital covered at different levels of the logistics agreement process.

After a material has been bought out, there are three possible outcomes, see Figure 4.13. The first one is that TPTS puts the bought-out material on stock and then eventually sells it to a customer, which according to TPTS staff, is the most common situation. The second one is that Tetra Pak puts in on stock, but there are no sales, and after four years, the material is scrapped. Finally, the item can be replaced or phased out for other reasons, making TPTS scrap the material immediately after the buy-out. This is often done directly at the supplier's site. To map

how each part is represented, the scraps Nov 2020-Jan 2021 were mapped against buy-outs to find situations where the buy-out was the scrapping reason. To make the analysis as objective as possible, situations, where material was scrapped for reasons that are not an effect of the LA were excluded, e.g., quality reasons. Scraps done at the suppliers were also mapped. In that data, there was no reason for the scrap or material number, only the supplier. Therefore, were all scraps for suppliers with an LA summarized. The result was that approximately six percent of all buy-outs lead to scrapping.

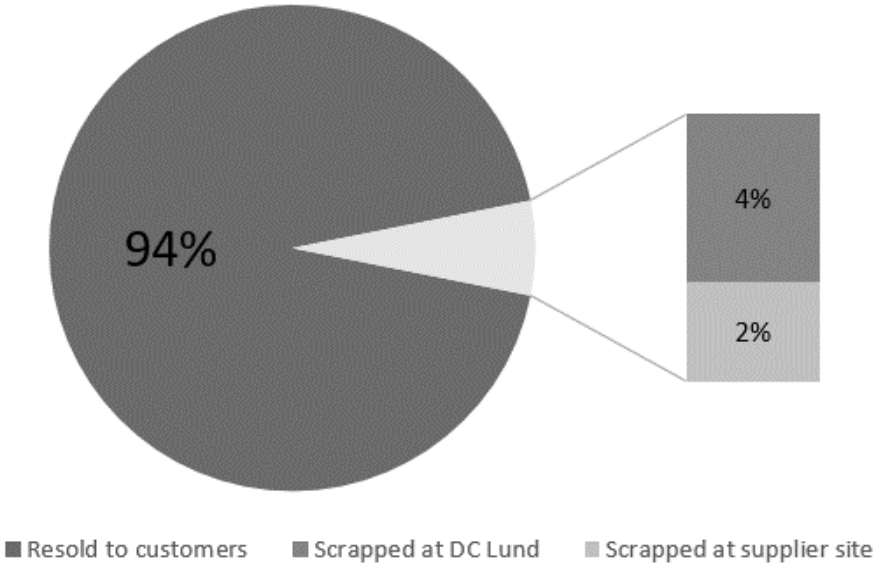

Figure 4.13. A chart showing what happened to bought out material. The data of the scraps are from three months, Nov 2020 until Jan 2021.

There are additional costs associated with the logistics agreement. As can be seen, in Figure 4.13, six percent of buy-outs are scrapped, and 94 percent are resold. However, a resold material still leads to additional costs. There are administrative costs in both managing the buy-outs and resells. Another aspect is the additional time in the warehouse for bought-out material. As there is no imminent demand, the bought-out material is placed in the warehouse for a substantial amount of time. There is no data to track how long bought-out material has been kept in stock before it is resold. However, it can be done for bought-out material that is scrapped at DC Lund. There scrapped material has, on average, stayed in the warehouse for 566 days before being scrapped. It can be compared to other ASL material, which is bought more or less on customer requests and spends a substantially shorter time in the warehouse. The extra stock-keeping days are an additional cost, determined by the warehousing interest rate.

When looking at the total cost of the LA, six percent of buy-outs are scrapped, and material is on average placed in the warehouse 566 days before being scrapped. The internal warehousing interest is 30 percent annually of the purchasing cost. Combining the capital scrapped for three months and the bought out quantity for three months, the relation between capital covered by LA and scrapped material is 0,088 percent. It means that the approximate cost of covering material with the LA is about 0,1 percent of the purchasing value.

4.3 Suppliers' perspective on LA

An important stakeholder in the LA is the supplier who signs the LA and upholds the agreement. Of the 50 suppliers who receive the most order lines by TPTS, 42 percent are currently ratifying the LA. Taking a broader approach, less than 15 percent of all TPTS suppliers have an LA. There is no clear connection between suppliers with LA, and the internal supplier categorization. A supplier can be deemed to be either a strategic, preferred, or a base supplier. Of the 65 suppliers with an LA today, nine are strategic suppliers, 30 are preferred suppliers, and 26 are base suppliers. The amount of ASL materials that each supplier has also differs, which can be seen in Figure 4.14 below. 80 percent of the materials delivered under an LA come from just 20 of the suppliers, with some being categorized as base suppliers. Generally are Tetra Pak's suppliers specialized in a specific segment, for example in custom welded parts, electric equipment and modules.

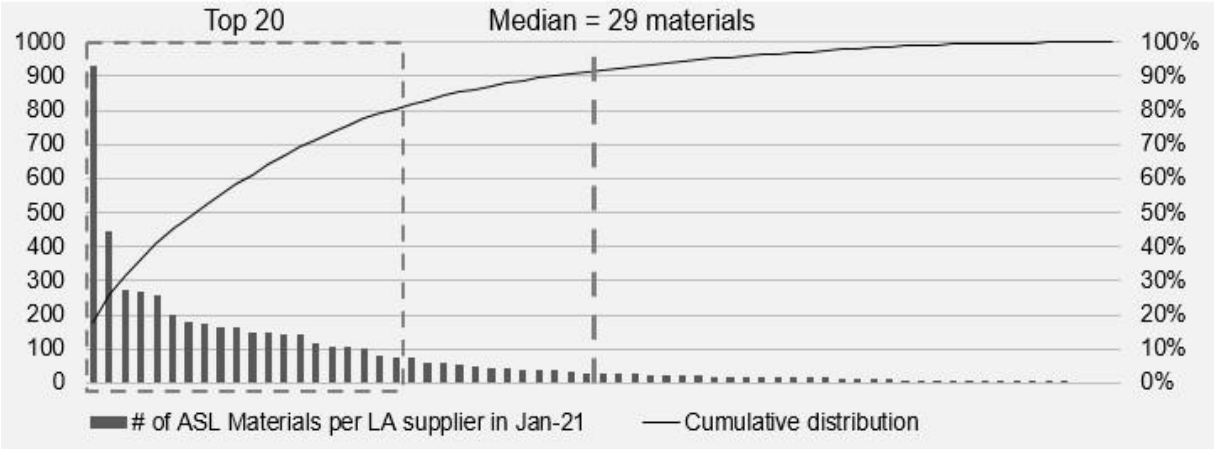

Figure 4.14. Graph showing the amount of ASL materials that each supplier with an LA delivers to TPTS. Numbers has been scaled, but the cumulative distribution is still correct.

4.3.1 Supplier input

During the case research, information from suppliers with an LA was gathered. The interview questions were based on the research questions. A complete interview guide can be seen in Appendix A – Interview Guide Suppliers. The authors reached out to more suppliers than the final participants, but some declined due to internal limitations to find staff suitable for the interview or information-sharing policies. The participating suppliers have all worked closely both with Tetra Pak and the LA. To visualize the results a summary of key areas of the interviews has been made and is shown in Table 4.1.

Table 4.1. Summary of findings and answers from interviews with suppliers.

Supplier:	*A*	*B*	*C*	*D*	*E*	*F*
Type of partnership	Prioritized	Close/long time	Close	Long time, very close	Close/ prioritized	Long time/ strategic
# ASL materials	149	88	166	266	30	105
Level of understanding LA	Believe good	Messy first, clear now	Good	Great	Good	Good
Process using the ASL-list	Manual	Manual	Manual	Manual	Manual by production	Manual each month
Resources needed for LA	Dedicated employee	Financial security and dedicated employee	Financial security	Communica-tion with SuM, shared forecast	Production planner, financial security	Dedicated employee, SuM at Tetra Pak, forecasts
LA necessary for LT reduction	Yes	Yes	Yes	For some materials	Yes	Yes
Benefits seen with LA	Spend less time per produced product	Can produce complex products before order	Improved LT	Improved planning and production, lowers costs	Forecast is better than from other customers, can build stock	Can maximize production, improved planning possibilities
Challenges seen with LA	Changing forecasts	Changing ASL list	Forecast accuracy	Over purchasing	Changing ASL list, hard to track buy-outs	Manual check of ASL list, over purchasing
Possible improvements to LA	Consider red dates and stacked LT	Stable ASL, easier corrections process	ASL to better match production batch sizes	Better ASL scope to have correct materials under LA	Interval for ASL, more and better fit materials in ASL	Ensure that LT goes back to pre-ASL if removed from list
Examples from other customers	Similar to LA	Use Kanban	No answer	No answer	No answer	Push to have stockholding agreements

Through the interviews, other relevant information and insights not shared in Table 4.1 arose. As mentioned in 4.2.1, PSC shares a list of the ASL materials and the ASL for corresponding material each month with the suppliers. While most suppliers manually check the stated ASL that month, some only check to see if a material they manufacture has been added or removed from the list during the half-year updates. There is no system to highlight if a material has been removed or added, so the suppliers have to compare the new list with the previous list. The same manual work is also needed to see if the ASL for materials have increased or decreased from the previous month. Some suppliers voiced frustration over this and suggested that improving the information sharing could save them from tedious work.

Another point raised in response to the ASL is that it is hard for the suppliers to always have the corresponding number of materials in stock. The problem is that production batches do not match the number of missing pre-made products in stock compared to the ASL. Some suppliers say that they do not want to take on the financial risk of having more produced articles than is covered through the LA, so they run a low pre-made stock until it is economically beneficial for them to produce a new batch. Other suppliers start a new batch, either way, believing that they will sell the excess stock in the future. One way suppliers described it was that they used the ASL as more of a guideline and then they produce within an interval of that number, giving the supplier better flexibility in planning when and how much they can produce of a material.

4.4 A look at comparative companies

To further widen the understanding, the master's thesis investigates central themes at other companies than TPTS. This was done through in-depth interviews at three different companies. These are not fully conducted case studies of each company. However, extending the view to perspectives outside the actual case company can give insights in similarities and contrasts to other strategies and processes used. The findings are presented connected to the three themes investigated.

4.4.1 Company A

The company works as both an internal and external deliverer of sealing and creasing components that they manufacture inhouse. The components are used in food processing and packaging machines, much like the machines produced by Tetra Pak. The company is also active in spare parts sales.

Purchasing
Company A purchases and plan their orders based on forecasted sales and current level of production. It is done through the ERP the company uses, which plans the purchases depending on factors such as internal and external forecasted demand, as well as the lead time of the material and current stock. The sourcing of the materials is done at a separate division that works for multiple companies within the larger parent company. That gives the company limited control over strategic decisions made regarding sourcing. Looking at strategic decisions for purchasing though, the company has different purchasing strategies for different groups of the around 500 materials they use in production. For bottleneck materials, which are signified by long lead times but with high volume of purchase, the company has a separate purchasing and stock handling agreement with the supplier than the other materials. The agreement looks

to drastically shorten the lead time and ensure the availability of these materials. The agreement will be presented further under the next section as the second policy for stock handling.

Spare Parts and Stock Management
The material purchased by Company A has high quality and tolerance requirements, which leads to that the lead times are long, often over 128 days. It implies that the company needs to send purchase orders before receiving a sales order. They first look at what on-site stocking strategies they should have for material, based on the parameters usage rate, price, service level and lead time. There is also a manual override possibility for each material, if for example the material is to be phased out or the product which need the material is being launched. The override is also connected to the second policy. Based on their yearly forecast, the company has an agreement with some of its suppliers that affects Company A's high runner materials. If a material falls under the agreement, a manual override for the first stock policy occur. The agreement itself stipulates that the supplier should always have between a min and a max level of pre-made stock. The min and max levels are based on the forecasted sale for the next one month and three months respectively, but the min level can also be set at the MOQ for the material if it is higher than the forecasted min level. If Company A orders less than has been pre-made by the supplier, Company A takes on the risk to buy-out the rest of the produced material that is not above the max level. Should Company A buy more than the max level, the supplier does not have to adhere to the 14 days lead time that is stipulated in the agreement for the orders above the pre-made stock. As mentioned earlier in the section, the agreement is especially for bottleneck items with long lead times, though another criterion is that the material needs to be an active material with a yearly sales forecast of over 200 articles. The number 200 has no data driven reason behind it and the company is evaluating if it is the correct level. Company A does though review min and max levels for the material under the agreement each quarter, and if a material falls out of the scope the company investigates why.

Supplier Collaboration
Company A emphasizes working well with and close to their suppliers. Each month they share a forecast with their suppliers regarding purchasing levels for the near future. The company also each week reviews the current stock levels of the suppliers shared by the suppliers, which gives an opportunity to see how the suppliers with a stock keeping agreement perform. While this does lead to manual labor, it has allowed the company to, together with the supplier, monitor performance related to the consignment stock agreement. Only the suppliers monitor if purchasing exceeds agreed levels, but it is an area flagged for improvement.

4.4.2 Company B

Company B is a world-leading manufacturer of industrial separators and heat exchangers that traditionally have close ties to Tetra Pak. There are several reasons why Company B is relevant for comparing with Tetra Pak; the companies are similar in size, they are in connecting markets, and both are active in the after-sales market. Additionally, the companies have a high amount of process integration with each other which can give findings additional relevance.

Purchasing
For company B purchasing is decentralized and done at a plant level. Each plant is responsible for their selection of materials and stock levels. However, there is an overseeing unit that can administer when materials have to be shipped between warehouses due to urgent demand. The overseeing unit will also give recommendations for materials and stock levels that is necessary to have in stock. Depending on the material classification, different strategies are used. There

is automatic release for orders with straight rebuys and high runner materials. For low-frequency material associated with more uncertainty, there is instead a manual release.

Spare Parts and Stock Management
Company B classifies their material into four different product groups: Stocked items are material which is always to be in stock. Generally, these items are high-runners, with the forecasts deciding the stock-keeping level. The second group is non-stocked standard items. The customer less requests these items, but the demand is still frequent. The materials are sourced to suppliers with set lead times, and customers can place orders with direct confirmations. However, the items are not kept in stock. The third product group is requested items. These items are rarely requested, and no material is kept in stock. Instead, the material is sourced to suppliers but without set lead times. Before a customer can place an order, Company B must confirm with their suppliers if they can deliver the material and at what lead times. The final classification is business items. The implication of the classification is the same as for stocked items, but they are classified based on business reasons instead of demand. It is used for situations where demand is expected to increase rapidly or for new product launches.

As it is a cost to keep stock, Company B wants to limit the number of items classified as business items and has created an internal incentives program. If a sales department believes an item that is not in stock should be in stock, they can send a formal request for the material. The warehouse will then put the material on stock as requested. However, if the material is not sold the way anticipated and must be scrapped, the sales department will be debited for the scrapping cost. However, according to the interview, this is rarely the case. Staff at company B are optimistic about the program, as it helps align incentives in the company between manufacturing and sales.

Supplier Collaboration
Currently Company B works close with their suppliers. The goal is to have several suppliers for each material, to mitigate risk. Due to lack of resources, unfortunately it is not the case. To manage several suppliers is resource intense and costly to administer, and generally they often, therefore, depend on single sourcing. The supplier's performance is carefully monitored. The most important KPI for suppliers is delivery accuracy. Suppliers that are underperforming will be audited.

4.4.3 Company C

Company C is a global industry leader in climate solutions. The company is relevant for comparison as they and Tetra Pak both have a large customer pool where a substantial business is to perform maintenance and service for their customers. Therefore, both companies, although different in size, share similar problems.

Purchasing
Company C has several distribution centers globally. The centers can both serve factories and the market. There are several suppliers available in the market, and the threshold to switch suppliers is low. However, to get continuity and enable prosperous relationships, contracts are signed with suppliers for preferably two to three years. If a supplier seizes to manufacture a material, Company C preferable wants to place a last-time order to secure availability to the end customer. Additionally, there is a general rule to need six months maximum for changing the supply of materials. To mitigate risk the company builds stock, and continuously update their pool of suppliers.

Spare Parts and Stock Management
Company C writes maintenance contracts for all sales, which stipulates how long they are responsible for supplying spares. Due to the irregularity of demand, Company C does not forecast spare parts. Instead, they work with safety stocks. The level of the safety stock is decided by cost and historical order frequency. Independent conditions can be manually added, for example, if an item is highly critical. Because the company only relies on its stock, it is highly prioritized to shorten lead times. Shorter lead times would enable the company to both lower stock levels and handle stock outs better.

Previously information regarding the installed base components has not been available, which has made forecasting impossible. Data is now collected from new sales, but it will take time before it makes an impact. Of the available data, the biggest problem is process integration, e.g., it is currently not impossible to incorporate critical data in the ERP.

Supplier Collaboration
Company C is working using the Kraljic matrix to identify product groups exposed to risk. For products that are classed as bottlenecks, the strategy is to move them to leverage items. They use two main strategies to mitigate the supply risk: Either contacting the bottleneck suppliers and being transparent that they are dependent on them. They then offer the suppliers a strategic partnership deal where the cooperation is intensified to secure supply. If that is not an option, the company actively starts searching for new material suppliers.

Suppliers are divided into three classes based on strategic importance. The highest importance is given to suppliers that are the single-source to a product and suppliers with several materials or unique products. The classification decides the level of attention the suppliers are awarded and prioritized factors for renegotiating agreements. For example, can the prize be deprioritized at the account of achieving shorter lead times for business-critical materials.

Company C prioritizes good relations with the suppliers, as they believe that it will give the best result. Although there are fines for late deliveries, there are seldom used. The company representatives mean that fines can cover the short-term losses that a delay can incur. However, ultimately fines will force the supplier to increase prices to break even, which will only hurt the buying company in the end.

4.4.4 Summation of comparative companies

The empirical information gathered from the case companies can be compiled into Table 4.2. The findings are summarized in the table to support the comparative analysis.

Table 4.2. Summary of findings from interviews with comparative companies.

	Company A	**Company B**	**Company C**
Consignment stock strategy	Yes, based on EOQ POD	No	No
Categorization	Yes, based on demand pattern and criticality. Newly implemented, but initial results are positive	Yes, based on demand pattern and criticality. Works well	Yes, based on demand pattern and criticality, though currently has issues defining criticality
Main method of risk mitigation	Consignment stock strategy + safety stocks	Multiple sourcing + safety stocks	Multiple sourcing + safety stocks
Most important KPIs for purchasing	Delivery performance and LT	Delivery accuracy	Leadtime and quality
Information sharing	Open, but on a need-to-know basis	Restricted - only selected information shared	Very open, high trust to suppliers. Information shared generously
Barriers for switching suppliers	High	Medium	Low

5 Analysis

This chapter is devoted to analyzing the case company, which is necessary to achieve the purpose of the study. The structure of the analysis will be based on the analysis model, presented in Chapter 3. Therefore, the analysis is divided into three different parts: what, who and why. The information gathered in the empirical chapter will be evaluated based on the literature review to find weaknesses and strengths with the current way of working. Here, the comparative companies interviewed will help to give perspective and either validate or refute findings. It will also help to connect findings to several companies which could possibly enable more general conclusions. Hence will the analysis lay the foundation to answer the research questions.

5.1 What

Understanding which materials a buyer-supplier agreement as to the logistics agreement should oversee is an important factor to the agreement's performance. The materials selected should be strategically aligned with what the agreement is trying to achieve. Further, for an organization like TPTS with over 600.000 spare parts in its portfolio, selecting materials must be done automized based on data in the ERP. The cost and effort of doing it manually would be colossal in comparison to the benefits gained. It emphasizes having available parameters that the ERP can screen the materials against through an automated process. To optimize the agreements performance, inventory placement and ownership are vital areas.

5.1.1 Part categorization

Tetra Pak uses several forms of categorization for parts based on criticality, specificity, and demand, aligned with the theory presented in the literature review. However, the categorization used for the consignment stock strategy is mainly based on the EOQ POD – which derives from the forecast. As established by Cohen et al. (2006) and Huiskonen (2001), spare parts are hard to forecast as the demand is volatile. The consequence for TPTS is that the ASL list contains approximately 2000 materials that continuously move in and out of the ASL scope. The suppliers have three months to build up stock in the current situation, and suppliers only occasionally update themselves on the current ASL scope. It means that suppliers rarely have the designated ASL in ready-made stock for materials with volatile demand. Further, the volatility of scope obstructs the possibility to follow-up on that the suppliers have agreed in the system with 14 day lead time. The lack of lead time compliance is because new materials continuously enter the ASL list, making the data on lead time hard to keep updated. Besides does the suppliers not send updates with their ready-made-stock levels for ASL. Not supervising the suppliers in these areas and having routines for sharing this type of information is an area that Liker and Choi (2004) argue can hinder successful cooperation.

Materials in the ASL scope with volatile demand have other implications as well. The correction process, identified as a frustrating problem by TPTS staff, is largely an effect of the volatile demand. Corrections are done when TPTS orders more than the ASL, mainly caused by poor forecasting. Further, buy-outs are caused by changing demand over time. Although demand will continually change over time, the risks of buy-outs should be avoided. It not only leads to scrapped materials but also increased stock levels and administrative work. If the

materials less than six months in the ASL scope would be excluded it would reduce the number of corrections and buy-outs. In addition, it would also help the suppliers with their production planning.

Taking a broader view of the overall supply chain, the instability in ASL list is a problem, especially for the supplier-buyer dyad. Several suppliers in section 4.3.1 mentioned the instability of the ASL list as a key problem. When a material enters the ASL due to increased forecast, the suppliers increases the production to maintain low lead times. However, if the forecast increase was just a temporary forecast spike, and the material at the next review falls out it causes demand fluctuations. Which according to Bozarth and Handfield (2016) is an optimal environment for having the bullwhip effect. The effect is increased stockpiling, and a less profitable supply chain.

An alternative solution to try to find more stability for the scope of materials is to use more data. If more parameters were used for determining the ASL scope, there would be more data on which to base the selection of materials on. The stability of the scope could be achieved by weighing multiple factors, as described by Huiskonen (2001) to determine the scope. Wallin Blair et al. (2020) argues that the consignment stock strategy should be based on three or four factors, of which TPTS are currently using only one as can be seen in Figure 5.1.

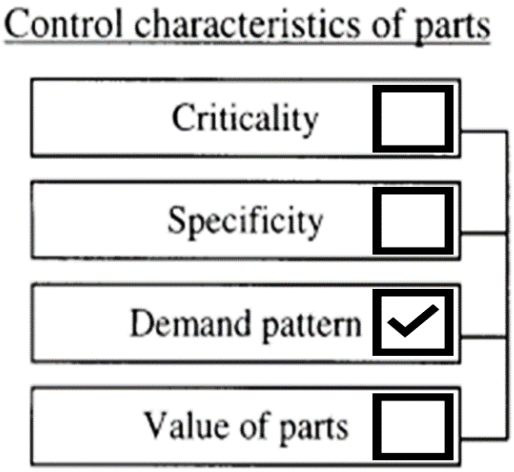

Figure 5.1. Identified control characteristics that is used by Tetra Pak to determine which materials that are in the ASL scope shown through checked box. Based on model by Huiskonen (2001).

However, more information is readily available. TPTS for example has information in their ERP regarding demand, but also criticality and price. The current issue is that different systems are used for various materials, as described in 4.1.1. Data for material used in packaging machines may not be available for materials used in processing machines. Nevertheless, as in line with theory, the assumption is that by developing a scope that builds on more stable factors than demand, such as price, specificity, and criticality, a more stable and effective ASL scope could be achieved.

5.1.2 Inventory ownership and placement

TPTS are currently using a variant of the consignment stock strategy, where materials are owned by the suppliers, but TPTS reserves them for a period of time. If no orders are placed, TPTS has liability for the value of the goods. The current group of materials included in the strategy are all ASL materials sourced from suppliers who have signed a LA.

Regarding which materials to include in the consignment stock strategy there is no consensus in literature, and different authors argue for different solutions. However, there seems to be somewhat of an consensus that the strategy is easiest to do for low value products with high demand (Zavanella and Zanoni, 2009, Battini et al., 2010). This also seems to be the case when comparing literature with the efforts of TPTS. Currently the greatest success are found for products with high demand that remain in the ASL scope over time. For these products the supplier has time to build up stock and deliver at 14 days, which enables TPTS to decrease stock levels at their site, and thereby costs. Likewise, are the biggest issues present for materials with less stability. Materials entering and leaving the scope, and variable ASL causes disturbance for both TPTS and the suppliers.

Another area of consideration is the ASL. To get them right is described by Gharaei et al. (2019) as a key area. For the issue, there is no readily available blueprint in literature that TPTS can adapt. Currently, the levels are based on the three-month procurement forecast. However, the weakness of the system is that the ASL vary too much, causing problems for the supplier's supply chain management. An interesting example from the comparative study can be found at Company A. They have adopted a max and min ASL for their consignment stock strategy. The supplier is, in other words, given an interval for which the finished stock level should be in-between. It does not necessarily solve the problem of instability of the ASL; however, it mitigates another problem where ASL that do not align with the supplier's production batches. Because, for the suppliers, the possibility to manufacture larger batches at convenient times renders lower costs and ultimately lower prices. With the current setup, some suppliers argue that the ASL do not suit their batch sizes. Furthermore, they are unwilling to produce more than the ASL as they do not want to risk having obsolete stock. With the current setup of the LA, it reduces some of the benefits for the suppliers.

When comparing the benefits with the consignment stock seen by TPTS and their suppliers with benefits described by Battini et al. (2010), there are several similarities, see Figure 5.2. The most emphasized by TPTS is more often having material on hand and drastically reduced lead times. TPTS seems to focus less on benefits such as reduced management cost and flexible production mix. From the supplier's side, the most mentioned areas are optimized production lot sizes, information regarding demand, and the long-term relationship commitment. In general, the suppliers seem to appreciate all aspects of the consignment stock strategy and mainly see the instability as an issue. TPTS are generally satisfied with the solution but seem to be more concerned than the suppliers, especially regarding if the cost and risk are in proportion to the benefits.

Benefits for the buyer		Benefits for the seller	
Material on-hand	☑	Optimization of transport	☐
Reduced management cost	☐	Optimized production lot sizes	☑
Lead times drastically reduced or eliminated	☑	Information sharing regarding the buyers' consumption	☑
More flexible production mix	☐	Long term relationship commitment	☑
Postponment of payment until material is used	☑	Vendors can stock according to assigned levels which helps them to have more space available	☑

Figure 5.2. The benefits identified for TPTS and their suppliers compared to benefits found in literature.

5.2 Who

Just like understanding what the buyer-supplier agreement should oversee, figuring out whom to sign the agreement with is also an important factor in the agreement's performance. Manufacturing companies like Tetra Pak can have varying possibilities to find suppliers that can produce the components they need. The suppliers differ in many aspects like size, manufactured product, and geographic location. Categorizing the suppliers can help determine the strategic fit when selecting the suppliers and the terms of cooperation in the operational work. The buyer-supplier agreement can for one supplier be intricate in lifting its performance, while for another, it may not add any benefits and only result in added risks for the buyer side. Further, setting up strategies for purchasing and evaluating the sources for materials in the agreement helps with the flexibility the buying company can have. Entering into an agreement with a supplier can ensure a long-term relationship, and looking at whether the relationship will be fruitful and positive for both parties is pertinent.

5.2.1 Sourcing strategy

The sourcing strategy is an incremental part of purchasing. As was established in the empirical data chapter, TPTS are using single sourcing exclusively, with very few exceptions. Of the benefits Bozarth and Handfield (2016) and Bildsten (2016) describes with single sourcing, TPTS are capturing two important with the LA: strong relationship with the supplier and economics of scale. Consequently, the LA is efficiently integrated and a complement to the current sourcing strategy. For the disadvantages, a significant difficulty with single sourcing is the risk of disruption. The LA mitigates that risk somewhat with finished goods at the suppliers leading to low lead times. It also works as an extra safety stock without the need to tie up capital for the buyer. The contractual agreement also formalizes and deepens cooperation, which Bozarth and Handfield (2016) argues can lead to a prioritization from the suppliers when the market supply decreases. However, a problem that remains, and something that the LA amplifies, is lost market knowledge. When TPTS offers a supplier the LA, the barriers for switching suppliers increases, and all focus is invested into that supplier.

When looking at the comparative companies, there are different sourcing strategies. Company B and C use multiple sourcing to keep several suppliers for a product, and if one does not deliver, there are alternatives available. Company B and C then have the possibility, which they use, to negotiate between the suppliers to find the best possible price. For TPTS, it could be a tempting option to use multiple or dual sourcing to mitigate the risk of supply and get the best price. However, it is currently not possible because of the market characteristics (4.1.2); the barriers to switch suppliers are too high. Just the costs of getting certificates and manufacturing test batches would, with high likeliness, exceed possible advantages. Beyond that, Tetra Pak would need system support and resources for administration. Due to their situation, they are then confined to rely on single sourcing. The consignment stock strategy could therefore be said to be a good way of managing supply risk by intensifying supplier relations in a market with high barriers for switching suppliers.

5.2.2 Supplier categorization

A categorization of suppliers is relevant, as it could help TPTS target for which suppliers an LA is most beneficial. There is currently no available categorization of suppliers or overall strategy to distribute the LA for the consignment stock strategy. There is a categorization available at TPTS, but it is not used for the LA. Instead, the suppliers have been handed the agreement based on a combination of data and arbitrary factors. The categorization, however, has been created by the supplier managers, and suppliers with critical material are sometimes ranked as standard or base suppliers. It is because the supplier managers do not solely base their categorization on factors that are not relevant for assigning ASL. Instead, it could be based on other factors relevant for other areas of Tetra Pak, such as the main production. Due to that, it is not possible to directly implement the current supplier categorization as a tool for distributing the LA.

Compared to how the comparative companies work with their risk-sharing solutions there are differences. Comparative Company C divides the supply according to the matrix created by Kraljic (1983). Then long term for all product in the bottleneck category the strategy is to either move the products to the routine product box or to increase cooperation with the suppliers to reduce the risk of supply. Company C's solution is similar to what Van Weele (2014) suggests for bottleneck products, which is to secure supply and search for alternatives. A weakness in

how TPTS work with suppliers is that there is no strategy for selecting which supplier segments a LA would benefit TPTS the most.

Based on how Company C works and literature, the Kraljic matrix could be adapted to be a base to determine which products, and in extension, which suppliers that the LA should target (Figure 5.3). The supplier that delivers products with high-profit impact and with high supply risk is definitely good candidates, identified by the darker grey shade in the matrix. The LA would for these products both decrease lead time and delivery performance, which would decrease costs and increase availability. The risk of supply is not as distinct for leverage products, but the LA could still offer better economic circumstances in certain cases. The relationship is vice-versa for bottleneck products. The financial improvement of the LA for these products would be minor, but it would decrease the risk of supply. However, there are costs associated with the LA, and the improvements should be measured against the costs. Therefore, are these two types of suppliers identified with a lighter shade of grey, as there may be cases where the benefits of having the supplier signing a LA could outweigh the costs. For suppliers with routine products, it is not necessary to have a LA, as the profit impact and supply risk are both low and the LA would not add any additional benefits.

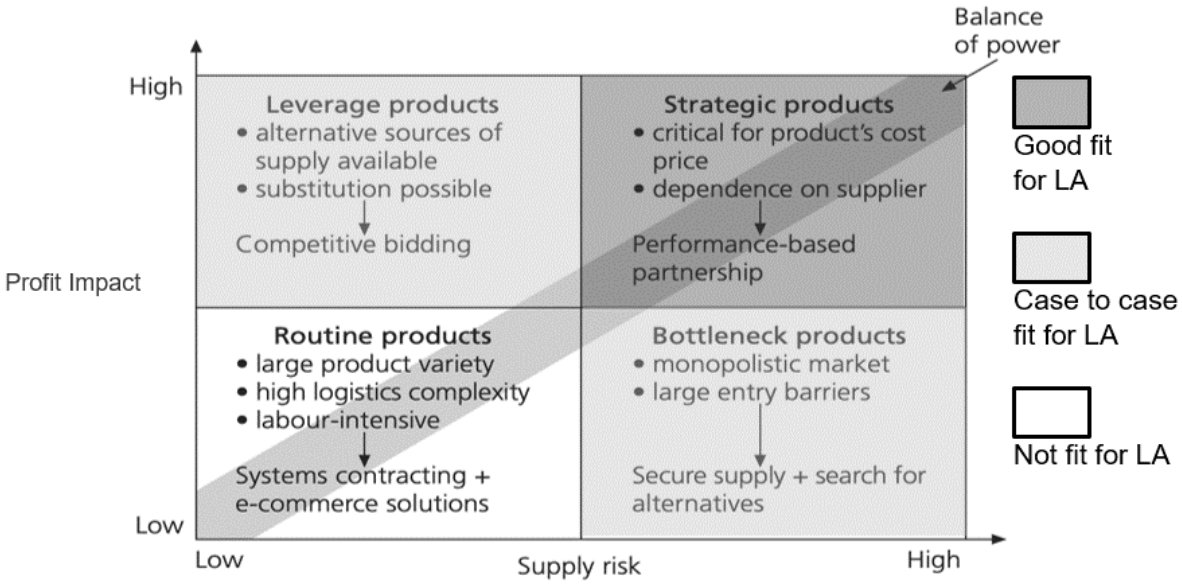

Figure 5.3. The Kraljic matrix adapted to show which product groups that benefit the most of a LA. Adapted from Van Weele (2014).

From the supplier interviews it is also evident that some suppliers are more enthusiastic regarding the LA than others. From the interviews in 4.3 somewhat of a trend can be seen in that bigger suppliers, generally OEM, like the LA less, while smaller suppliers like it more. It could be a number of reasons as to why. The smaller suppliers have less sophisticated ERP systems which make it harder to forecast demand accurately. It could be a reason to why they appreciate that TPTS helps them with the production planning. The smaller suppliers are also less financially stable which makes the economical side of the LA more needed. It is consistent with theory presented by Zavanella and Zanoni (2009), that a consignment stock is most beneficial when a large company buys from a small to medium sized company. However, it is hard to thoroughly validate as it was challenging to get interviews with large suppliers. Both because for those sorts of companies, it is challenging to contact a single person who has complete insight into the LA process, as the responsibility was split between several roles and

divisions. Also, the big companies have policies that bound them from conducting those types of interviews because of bureaucratic reasons.

5.2.3 Purchasing strategy

As the LA is a major cross-functional scheme that is cross-functional and affects the performance of several KPIs, it is, according to Van Weele (2014), vital to align the purchasing strategy with the LA. The LA should be an incremental part of decision-making regarding the overall purchasing strategy of Tetra Pak and TPTS. Decisions regarding the overall goals and KPIs should be taken at the strategic level. Currently, the LA is aligned with the overall strategy to have delivery performance and availability as the main KPIs.

In the LA process, most decisions are taken through routines and rules; for example, a set of binary criteria decides materials included in the ASL. However, one critical decision is taken: which suppliers are given an LA. The Supply Chain Analyst currently decides whom to offer the LA to, and it is done without any formal criteria. The decision the supply chain analyst takes has a direct impact on the LA scope. It can be argued that the decision affects the medium to long term direction of the company. Beyond that, the decision is cross-functional, as it affects several departments. According to the classification of Van Weele (2014) the decision for handing out the LA is tactical.

Currently are the companies that have not signed an LA generally larger OEM. It corresponds to the views of Gharaei et al. (2019), that bigger suppliers are less financially vulnerable to orders from a single customer. Frequently bigger suppliers sell the same products to several customers and heavily invest in material and production equipment. Therefore, they do not benefit in the same way from one customer giving them financial coverage for orders. Likewise, it is the smaller suppliers that are the most positive towards the LA. They are more exposed financially; capital coverage in material for a batch can strain the liquidity. For them, financial assurance makes a difference in a completely different way.

5.3 Why

The driving question behind forming a buyer-supplier agreement should always be why. Why do we need to have this agreement, and what are we trying to achieve with it? For the logistics agreement, the ideas of more fair risk-sharing, together with improved availability and supplier collaboration, are the incentives behind the consignment stock strategy. For a company active in the after-sales of spare parts, availability is one of the most important but also the most challenging areas to optimize. Availability is affected by multiple factors, such as lead time, stock value, delivery performance, and customer demand. Further, it makes it challenging to improve, for agreements like the LA, as improving one factor may decrease the overall performance. When joining as a party in a buyer-supplier agreement, it is vital to contemplate the benefits that can be achieved and what one is willing to pay to achieve it.

5.3.1 Risk-sharing

There are many different forms of risk-sharing. The main objective is cooperating in a way that helps both companies. The consignment stock strategy enables the suppliers to invest in raw materials and production to keep a finished goods stock. In exchange, the buyer cover the risk

of unsold gods, and if the assigned levels are not sold, TPTS will buy them anyhow. In section 3.5.1 regarding supplier cooperation, this kind of setup is encouraged by literature, and there are many different examples of it. Because to share resources and risks of investments in this way, as described in the supplier-partnering hierarchy by Liker and Choi (2004) and motives and gains with cooperation by Johnson and Houston (2000), is a great way to capitalize on good supplier relationships. Especially for pending transactions and investments the LA can help the suppliers take production-related risk at an agreeable cost for TPTS. These theories are corresponding to what the suppliers say the LA help them with. Although Tetra Pak rarely need to buy out material, the commitment that TPTS offer suppliers gives the security to produce on a 14-day lead time.

One area that is contradictory in terms of risk-sharing is the MOQ set by the suppliers. It is used to improve the margins for manufacturers in the production. The problem is when it is combined with the LA. As can be seen in Figure 4.5, the MOQ is the deciding factor for 15 percent of the ASL materials. The issue is also that materials with an MOQ are excluded from the ASL scope altogether. When the MOQ is high enough so that EOQ POD increases to over 50, the materials ends up outside the scope. As the LA enables the suppliers to produce to stock, the supplier can use machine downtime to produce LA materials and produce bigger batches. For suppliers to have both LA and MOQ, it then becomes a double premium, without the same marginal improvement for TPTS.

Currently, the LA solution is a consignment stock policy with elements of a performance-based contract included, as the benefits only are given based on that the suppliers deliver at 96 percent delivery performance and 14 days lead time. For performance based contracts by Selviaridis and Norrman (2015) argue that hinder of success is setting up an infrastructure regarding the performance indicators of the contracts. It is something that TPTS has somewhat overcome as the processes today regarding the LA work smoothly, although rather manual.

5.3.2 Availability

Availability has been identified as the key performance indicator for the consignment stock strategy at TPTS. It is validated by academia, as availability is also the primary performance metric for the after-sales supply chain established by Cohen et al. (2006).

Although availability is an overall important factor, materials that fall under an LA have a clear leverage ratio, as can be seen from the distribution of different materials in terms of order lines and purchasing cost (Figure 4.2). Effort to increase efficiency and effectiveness for these materials does therefore have a bigger impact for the total availability. It motivates the decision to work extra with for LA materials with consignment stock strategies.

However, it is difficult from the empirical data to determine to what extent TPTS are benefitting in terms of improved availability from the consignment stock strategy. As only the present lead time is registered in the system, and there are no historical lead times, the lead time reduction cannot be quantified. One problem, however, is lack of compliance. From the empirical data (4.2.5), it can be seen that several materials that are LA do not have 14 days lead time. The main explanation as to why some lead times are not 14 days is the volatility of scope. TPTS staff do not have time to follow up and adequately update material lead time. Still, for a majority of the materials the lead time registered in the system is 14 days.

One area where reductions can be validated is delivery accuracy or delivery performance. It can be seen in Figure 4.11 that materials with a logistics agreement achieve a higher delivery performance than their counterparts. Even when segmenting away other factors and just focusing on materials that fall into the ASL scope, the ASL materials purchased from suppliers with an LA outperform those from suppliers without an LA. There is a clear link between availability and delivery performance; if it arrives in time at TPTS, it can arrive on time at the customers' site.

It can be said then that the LA both drives reduced lead times and increased delivery performance. The delivery performance for LA material is higher than the average delivery performance, over 95 percent. It means that approximately 95 percent of all LA orders are delivered on the agreed upon lead time, which should be 14 days if the system is updated. Interviews with the suppliers further established this version, and that generally, the materials that fall in and out of the scope, are those with lead times longer than 14 days. However, due to lack of data it is not possible to exactly determine. Further it is not possible to calculate the lead time reductions as a result of the LA. However, based on the assumption that the consignment stock strategy reduces the lead times, the stock levels are reduced due to the LA.

The increased availability for the ASL comes at a cost in terms of buy-outs. In Figure 4.13 it can be seen that a majority of materials bought out are resold, but some are scrapped. When including the warehousing cost for scrapped material, the total cost of the LA is currently 0,088 percent of the total capital covered. It is hard to value the size of the cost. Although the consignment stock policy is not uncommon, the terms of the agreement differ between companies. However, the option for TPTS would be to keep the materials in stock. Worth to mention is that cost of the LA is calculated high. The traceability of the ERP is low, which meant that all materials scrapped at a supplier with a signed LA has been included in the cost. All scrappings due to obsolescence and no demand at DC Lund for bought out material has also been included.

Although it is not possible to compare the cost to how other companies work with a consignment stock policy, the cost can be weighed against the benefits of the LA: TPTS can lower their stock levels considerably, have low lead times, and high availability for the cost of 0,088 percent of the order value. It can be compared to the end goal of the LA, which is to have excellent availability in combination with low stock value levels and low lead times.

5.3.3 Supplier Collaboration

Examining the literature and the interviews conducted the LA definitely seem to improve supplier collaboration. This type of cooperation is beneficial. Both Nyaga et al. (2010) and Gutierrez et al. (2020) argue that formal initiatives like the LA increases growth, lower operating costs and increases the commitment and trust in the cooperation dyad. It can only be achieved with trust between the parties. Tetra Pak has long-standing relationships with many of its suppliers with an LA, which is an enabler for success. Further the LA helps to improve the relations further going forward. Specific components of the agreement also seem to be important for the two sides. Suppliers appreciate that TPTS makes corrections to their evaluation scorecard if TPTS has purchased more than approved in the agreement, creating a sense of fairness. For Tetra Pak, it is fair as they are only liable to buy out materials from suppliers who achieve the targets TPTS has stipulated in the agreement and the LA giving them another tool to push their suppliers to perform to their standards.

Not everything works smoothly with the LA, though, from the perspective of supplier collaboration. Currently, there are issues, especially in how the LA is communicated to suppliers and how integrated it is in the internal processes. While PSC is the agreement owner, the SuM division has direct contact with the suppliers. Due to the organizational setup and lapses in information sharing, the SuM does not always comprehend and use the LA in the best way towards the suppliers. The result is that a plurality of key suppliers has not signed a LA. It could be a mutual miss of opportunity as the suppliers who have signed an LA all appear to be satisfied with the agreement, and TPTS are benefitting from having LA material. Though there are some pains with the LA for suppliers that have signed the agreement, they could be solved with more straightforward communication and improved collaborative processes. For the buyer-supplier agreement to work, the parties have to establish good collaboration and relationships.

The model introduced in the literature review by Liker and Choi (2004) regarding how companies should work with suppliers is considered the benchmark model for good supplier relationships. By reviewing how the LA affect the areas suggested by Liker and Choi, it gives an insight into areas that currently are successful, and possible improvements. As can be seen in Figure 5.4 below, the LA improves supplier relationships in four of six steps.

Figure 5.4. Identified areas of the supplier-partnering hierarchy that the LA helps TPTS and its suppliers achieve.

The LA and the shared ASL act as a tool to share information in a structured manner and helps to monitor and control suppliers with essential materials continuously. Beyond that, it enables close project-based cooperation to improve mutual practices. During the interviews in this thesis, multiple examples have been shared of how Tetra Pak performs workshops with their LA suppliers to improve how they work with fulfilling the agreement. It shows the benefit of the LA as a facilitator for improving supplier relationships.

However, there are areas in which the LA is not contributing. Understanding the suppliers is at the bottom of the supplier-partnering hierarchy and a key area, according to Liker and Choi (2004). Lack of supplier understanding can also be seen as one of the weaknesses with the LA, as the ASL are not adapted to the supplier's production. If the supplier's situation is considered, then the ASL could be adapted for both TPTS needs and the supplier's production capabilities. Poor understanding of the suppliers is also present when looking at which suppliers need a LA. As mentioned before, the suppliers with the greatest need are not necessarily the suppliers that receive an LA and vice versa. The other area in which the LA is not currently contributing is to develop technical abilities. However, it is an area that other divisions of TPTS are working with, and it is not as relevant regarding what the LA sets out to achieve.

5.4 Summary of areas in literature model

From the analysis model, based on the model developed in the literature, it is evident that TPTS has both strengths and weaknesses in all areas. To give an overview of the strengths and gaps to the literature and the comparative companies all the areas have been compiled in Table 5.1. The table helps to show what is currently successful, but also to cast light on problems that are present for several areas. The table was also used to guide which areas to investigate further, explored later in the next chapter of the thesis.

Table 5.1. Different areas from the analysis model with success areas and gaps to literature and comparative companies.

Parameter	Current success areas	Gaps identified
Parts categorization	Automated process based on varibles in the ERP gives high efficiency	There is a need for more parameters which to base a categorization on
Inventory placement and ownership	Overall aligned the practice with the business strategy	Not identifying which materials are the most suited for the strategy. Lack of compliance for materials that are not stable in the LA scope
Supplier categorization	LA is handed out to strategically and historically important suppliers, who generally appreciate the LA	A lack of instruments that can determine which supplier that benefit the most from an LA
Sourcing strategy	Cross-functional decisions regarding which supplier gets a LA	Formalize the handing out LA process to find suppliers that benefit from the LA
Purchasing strategy	The LA complements the single-sourcing strategy by TPTS	Continue to find segments of products with high supply risk and distribute LA in order to lower supply risk
Supplier collaboration	The LA enables close cooperation with the suppliers improving the relationship and creates joint improvement	Process integration and communication. Lack of understanding of the suppliers position
Availability	The LA increases availability at a cost lower than keeping it in own warehouse	Create possibility to identify critical materials to then hand out LA to increase availability
Risk sharing	TPTS and supplier get security at a reasonable cost. Infrastructure in place to facilitate it	Instances of double coverage for the supplier with both LA and MOQ

6 Discussion

The thesis aims to ultimately develop a general model to enable guidance for future logistics agreements. Based on the previous chapters, several aspects of Tetra Pak's processes can, in combination with literature, be used to develop a general model. However, there were several areas Tetra Pak's current processes that are less successful. Before answering the research questions and fulfilling the purpose, these areas were further explored to find a best-in-class method to form a general model to implement logistic agreements. This chapter was divided into two different sections. First, a discussion was made regarding the available data and which analysis could be done. After that, a section was devoted to discussing and improving different areas.

6.1 Data availability, quality, and traceability

This chapter is devoted to further analysis of the identified areas of improvement. However, one main issue for the analysis was that data availability during the thesis has varied. Access was granted to all of Tetra Pak information system, so data has been available in that sense, but the usability has been varying. The most significant issue was the lack of cohesive historical data needed to do specific analyses. A clear example was when trying to analyze the LA's effect on lead time reduction, Tetra Pak staff had missed updating values over time, making the data set corrupted. Another critical issue was the traceability of the data. Generally, only one material number was available to identify materials, and the database would only save the most recent input. So, it was almost impossible to see, for example, the implications of late deliveries and how changing different variables would affect the performance.

For solutions testing, this was also a problem. The data needed to investigate the potential performance for some of the solutions proposed was not available and could take a long time to gather. Like many companies, Tetra Pak has more data than they know what to do with and has to delimit what data to use. It created cases where the data needed was not stored by Tetra Pak, or the quality of the data was too subjective to use for testing scenarios. Further, due to the complexity of the database and Tetra Pak's operations, it was also challenging to lock factors that were not tested in the simulation.

There were areas where quality data was available, and in those cases, it was possible to argue for a change through quantitative analysis. It was also possible to validate solutions that closely resembled the current situation, as then only minor changes were needed, making it possible to simulate. However, within the scope of this thesis, the resources and time were not available to simulate a solution where several parameters were changed. It would also lead to hypothetical scenarios, as there was no time or way to test how a change would be adapted and implemented at Tetra Pak and the suppliers.

6.2 Improvement areas

TPTS are doing several things right with the consignment stock strategy. They are working close to their suppliers, and the strategy is mutually beneficial. They are aligning the consignment stock strategy with the overall business requirements. They have automated several processes enabled by a well-developed technological infrastructure. With these critical success factors, they are enjoying some success with the LA – high availability at a low cost. However, there are still issues present, that are hindering a full success of the LA strategy. This section will further explore these areas, and solutions to diminish or remove their impact.

6.2.1 Instability of scope

One area that has diminished the success in several areas from the analysis model is materials falling in and out of the ASL scope. A too large turnover of materials in the ASL list reduces several of the suppliers benefits of the strategy: disruptions of the production planning, a removed possibility to optimize batch sizes and produce when machines are less busy. The supplier's benefits are crucial to the success of the consignment stock strategy, as it significantly decreases their production costs. The instability of scope means that materials are added to ASL list only to be removed a few months later. As the suppliers spend three months to building up stock of a material that then is not covered by the LA, the added availability diminishes. Although Tetra Pak has a well-developed information framework, too much turnover of materials still creates confusion. Several problems can be traced to that, e.g., incorrect lead times for materials that fall out of the ASL scope, and a lack of compliance for materials that are included. Another symptom of this is also an accelerated number of buy-outs. Ultimately, it creates a situation that increases risks and costs, with little added benefits in terms of availability.

A part explanation for the instability is due to the underlying nature of spare parts; the lifetime of components is next to impossible to predict, making demand volatile. However, a part of the explanation is also due to how TPTS selects data. Snapshots in time of the EOQ POD is the primary tool to determine the ASL list. Using snapshots based on a single variable further magnifies the underlying volatility. To increase stability, the solution should consider more data points, which would decrease the impact of temporary spikes in demand. Several control characteristics should be used for spare parts instead of solely relying on the general control characteristics for forecasting, which is demand.

If instead basing an ASL list on several criteria suggested by the literature, such as criticality, price, specificity, lead time and demand variability, a more stable system could be created. Moreover, could such a system help map impact according to resource spend. The spare parts that TPTS sell varies much in factors like price, complexity, and lead time, increasing the complexity for a one-size-fits-all solution. Although such a solution would be desirable, it is currently impossible due to the lack of data. Except for demand, are there for a majority of materials no other control characteristics present in the ERP. For some segments, the data is available for selected materials. However, a multi-dimension solution would be dependent on having this kind of data readily available and system integrated in Tetra Pak's processes. To introduce these variables in an accessible way in the ERP system would demand a tremendous amount of work. Doing it solely for introducing this kind of ASL solution is not cause enough. However, data is being added continuously, and TPTS should wait until a higher level has been reached before introducing a multi-dimension solution. Until then, efforts to base a spare part

categorization on multiple criteria should be postponed. Therefore, this solution will not further be investigated in the TPTS context.

However, there are other possibilities within the current data available to stabilize the ASL scope. For example, several relatively basic mathematical formulas could give a more thorough decision basis. Based on the rolling average formula, three additional scenarios in addition to the current were tested to find more stability for materials included in the ASL scope.

(1) Today's selection of ASL materials - shows the current situation, and acts as a baseline to other improvement solutions.

(2) Rolling average - same selection criteria as todays, except that a rolling three-month average EOQ POD was calculated.

(3) Hybrid - same calculations as the rolling average with an extra gatekeeper to make sure materials do not fall out in vain. For the biannual review when materials fall out, an extra check is done to see if the EOQ POD of the review month is in the scope. If that is the case, the material stays.

(4) Rolling average with a locked scope - rolling average of three months, but materials can only be included and excluded during the biannual review, and in between the scope is locked.

The four different approaches were reviewed based on how many total materials there were in in the ASL scope, how many unique materials were in the scope and how long the materials stayed in the scope. Finally, the stock value was calculated to understand the financial implications of the solutions. By doing the analysis with locked scope, the ambition was to find a scenario that enabled stricter compliance. By locking the scope, materials can only be turned around twice a year. The results of the four alternatives can be seen in Table 6.1.

Table 6.1. Four different scenarios, based on historical data of 18 months, for how the ASL scope can be updated by changing different parameters. The stock values have been scaled due to confidentiality reasons.

1 Today's selection of ASL materials
If a material at the point of updating ASL list has an EOQ-POD of >=10 and <=50, it will join the list. Can't fall out until half-year update.

2 Rolling three month average
If the average EOQ-POD for the month and the two previous month is >=10 & <=50, it will join the list. Can't fall out until half-year update.

3 Mix of (1) and (2)
Like (2) but if the material is outside at half-year update, it will still be in list if the month is within >=10 & <=50. Can't fall out until half-year update.

4 (2) with locked list between half-year updates
In Feb and Aug the ASL-list is selected from materials with 3-month rolling EOQ-POD like in (2). Can't fall in or out between half-year updates.

	1	2	3	4
Avg # ASL materials	11200	11592	12194	10304
STD ASL materials	987	916	715	115
Unique ASL materials	15803	15974	16678	13530
Stay all months	6880	7625	8159	7625
# short[1] stayers	2518	1233	1026	0
Jump out and in	2651	1242	1120	380
April # LA materials	4627	4443	4549	4065
Stock Value Apr[2]	€1,000M	€1,003M	€1,002M	€1,007M

1) In list for <= 3 months before falling out again; 2) If all LA materials followed LA rules for LT

From Table 6.1 it can be seen that using a rolling average positively influences the standard deviation for the three alternatives. The number of unique ASL materials decreases in relation to the average number of materials, which should be a goal, as it means a more stable scope. For the three alternative solutions, the number of materials that stayed all six months also increased. Further, also the number of materials that jumped in and out decreased. The only area in which the current scenario performs better than the alternative solutions is the stock value. It is higher for the alternative solutions because the calculations were made in a way that if a material fell out of the scope, it was put back on the average lead time for all materials. Then, when the stock value was calculated from that, the option that had the most materials with the lowest lead time performed best. However, the takeaway is that changing the parameters in this way will not increase warehousing costs tremendously.

Variance of the ASL list should be minimized to make it easier for both the suppliers and staff at PSC to administer and follow up on the ASL list, and to minimize the negative economic impact of buy-outs. The target should be to have as many ASL materials as possible that stay for all months to get stability and decrease the number of buy-outs and corrections. Interviews showed that one of the main problems that the suppliers faced are materials moving in and out of the ASL list, as it drives up economic costs and resources spent on planning. There is currently not enough time and resources to go through the list of materials each month and check each material's performance. As described in solution four in Table 6.1, locking the scope should enable TPTS to have better compliance. Setting biannual reviews for the scope would simplify the process of identifying and following up on materials, making sure that the materials have the proper lead time, and that the supplier is building up their stock. Therefore, the solution that gave the most satisfying result was solution number four based on these set-out goals.

The takeaway is that the current solution can be improved. E.g., a locked scope based on an EOQ POD with a rolling average would perform substantially better than the current solution. There are more parameters to uncover and further sensitivity analysis that should be performed. It can, however, be established that the current way of working in terms of the scope, using snapshots in time of the EOQ POD, should be improved.

6.2.2 Instability of stock level at the suppliers

Asides from the ASL list instability, there are also other areas that are less successful. One area that is represented across the analysis model is the instability of the ASL. This instability is a driving factor for several problems, such as corrections, buy-outs, and it confuses both the suppliers and TPTS. When materials under a LA vary in ASL too much, it causes demand fluctuations, and ultimately the bullwhip effect, decreasing profitability along the whole supply chain. Although the suppliers have a finished goods stock, they have to plan their supply, and too frequent changes in ASL make their supply more difficult. Levels are also not adapted to the material. Materials that take the suppliers two months to produce and materials that can be produced in a day get the same conditions.

To decrease the instability of the ASL is complex. As concluded in 3.4.5, there is no standard formula to calculate the ASL, and it has to be reviewed case-to-case. TPTS are basing it on the forecasts, and therefore it will vary. Possibly, a similar solution as in Table 6.1 could be investigated, but it will not necessarily increase the stability in a satisfying way.

For the other issue, to prevent the suppliers from getting exposed and finding the most suitable materials to include in the consignment stock strategy, the suppliers lead time should be

included when selecting ASL. It would enable a flexible approach, where levels are adapted to the supplier's situation. A weakness identified in Table 5.1 was a lack of understanding of the supplier's position, and this suggestion would help solve that issue. For materials with a long production lead time that requires multiple production steps, the ASL could be adapted to support them more. Likewise, it would also be able to identify materials with shorter lead time, where lower ASL are necessary, if any. However, currently, there is no system support for such a suggestion. The ERP can only track one lead time, and there is no communication for LA materials on how long the suppliers need to manufacture. In order to implement a solution with ASL based on the suppliers lead time both system support and communication routines with suppliers needs to be created.

However, although no data is available regarding the supplier's production lead time, improvements could still be made. The ASL would still be created from the purchasing forecast but considering factors that create flexibility for the suppliers. With that, a more flexible, supplier adapted ASL would benefit both TPTS and the supplier. The supplier would better be able to plan their production to increase efficiency in their processes, and better match optimal batch sizes. Both these factors would decrease the supplier's costs, and ultimately enable them to offer TPTS lower prices. In practice, it could be used similarly as case company A, with a max and min level. It would enable the suppliers to be slightly under or over ASL, enabling larger batches and a lower cost. The gap between max and min cannot be too significant, as it could increase capital covered by TPTS too much. Nevertheless, a smaller gap could benefit the suppliers while at the same time not increasing TPTS' exposure. When given an interval, the supplier can start a new batch at an earlier stage to be slightly over the current ASL. The alternative, which is currently used by the suppliers, is to only start new batches so that the ASL are never exceeded, as the suppliers do not want to have finished stock which is not covered by the LA. According to that assumption, a min max ASL for a supplier with batch size four, a 20 percent deviation should give the following curve (see Figure 6.1).

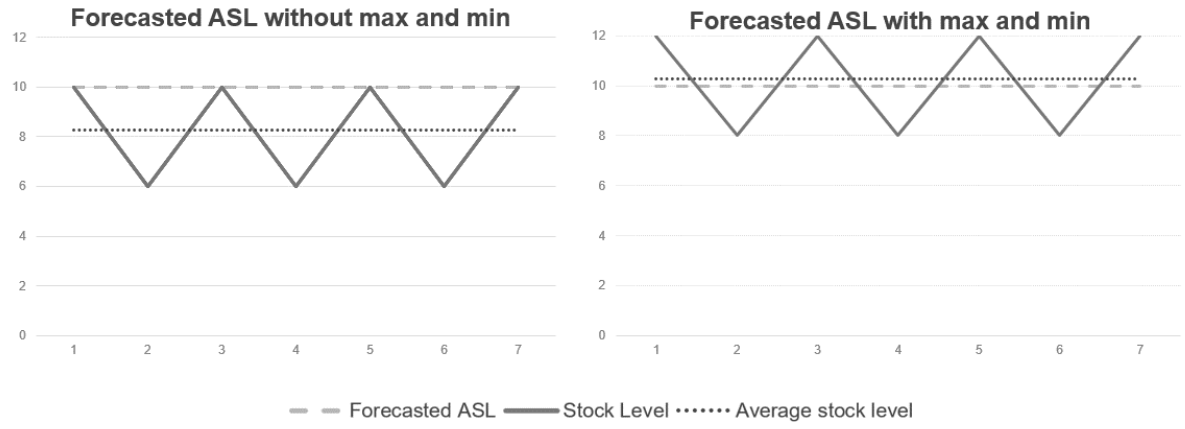

Figure 6.1. The current finished stock level at the supplier (left) versus how it could be with an allowed 20 percent deviation (right).

As can be seen in the graph, the advantage of using a max and min level is that the suppliers would hold a higher average stock level. It would in turn increase the availability for TPTS and decrease the likeliness that the suppliers run out of stock. The average stock kept by the supplier would be almost identical to the present ASL, instead of being well below as is the case today.

6.2.3 A lacking evaluation process for handing out LA

The final area needed to be explored further before including it in a general model is the supplier collaboration process — both how to collaborate with suppliers and which suppliers to cooperate with.

As previously mentioned, there is a lack of understanding regarding the supplier's position. A contributing factor to that is that their production lead time for LA materials are not tracked. However, this problem is not unique to the LA context. Overall, the company does not track lead time reductions. It is problematic as the lead time has a direct correlation to the purchasing cost. Focusing only on purchasing price creates a silo mentality, without focusing on the company's overall good. Therefore, the recommendation is to review suppliers based on their actual lead time reduction, as it directly corresponds with the total cost.

Regarding how to select suppliers to cooperate there has previously been identified that more structure is needed to implement a business strategy. Based on the current situation, the LA has two main benefits: it decreases the supply risk and increases the profit impact for long lead time materials. With these two parameters in mind, the suppliers should be evaluated based on the materials they deliver, see Figure 6.2, based on the adapted Kraljic matrix (Figure 5.3). This model would act as a complement to the current decision process. The efficiency of the process should be improved by keeping the positive parts, the cross-functional parts, and complete them with tangible factors to evaluate the supplier.

The potential vulnerability of the model is that it is based on material characteristics but is used to evaluate suppliers. For example, could one supplier sell products that belong in different boxes. However, for TPTS’s supplier base, the suppliers are specialized in a specific segment, e.g., unique welded parts, electrics, or consumables (mentioned in Chapter 4.3). For example, could the whole product category consumables be placed in the routine product box, making the suppliers with a high share of their product portfolio being consumables not suited for a LA. Therefore, the graph is relevant for Tetra Pak's suppliers, as the suppliers generally only deliver one segment's products. However, this reality could be unique to Tetra Pak, decreasing the applicability to use the model in other circumstances. When using the model for other companies with other prerequisites, this fact should be kept in mind. In those situations, the summarized placement has to be applied when reviewing the supplier.

Further, does the model not cover all relevant aspects of deciding which suppliers that gets an LA. Other factors to consider are supplier relationship, history with Tetra Pak and current performance. However, the model would provide structure and enable a longtime strategic goal to be carried out; to give increased availability with short lead times and low stock levels at the lowest cost possible.

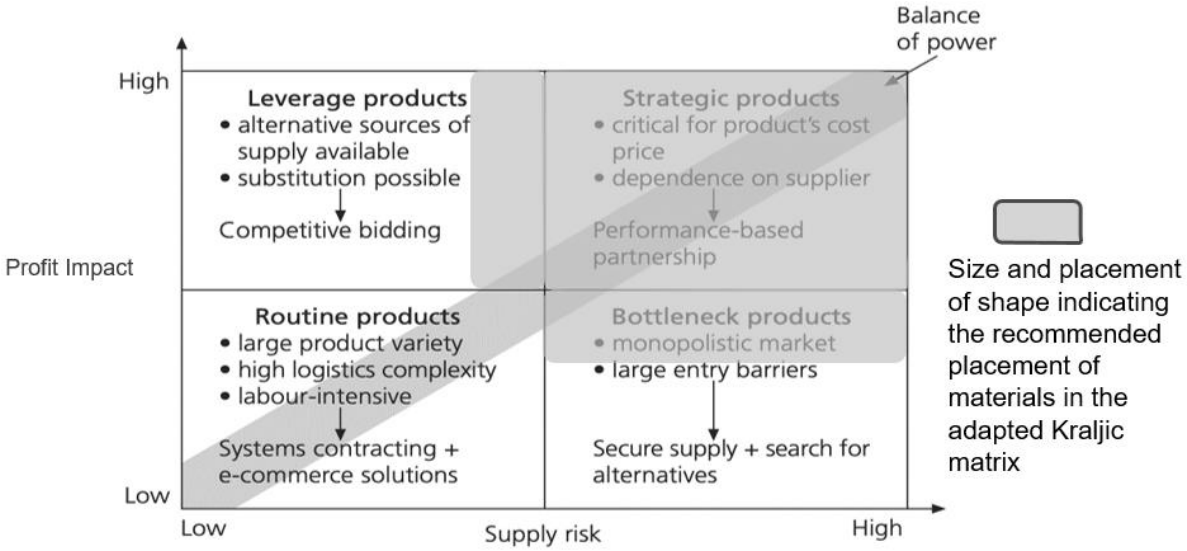

Figure 6.2. Areas in the Kraljic matrix for which suppliers should be selected.

7 Conclusion

This chapter will present the conclusions and findings of the thesis, culminating in answers to the research questions. A recommendation for how Tetra Pak can establish a general model for buyer-supplier agreement in the after-sales will be presented within the answers. After that, the chapter will discuss the research's contribution to the theory and possible practical implications before moving on to ideas for future research.

7.1 Conclusions

The purpose of this thesis was to *assess how a manufacturing company participating in after-sales services can improve buyer-supplier agreements, i.e., the logistics agreement.* This purpose can be seen from two perspectives; (i) an effort to develop a research area connecting buyer-supplier agreements with after-sales services; and (ii) help PSC at Tetra Pak with understanding the impact that the logistics agreement has on their operations and how they could optimize its performance. To fulfil the purpose, three research questions were formed which were answered in the following sections.

7.1.1 RQ1: What are the advantages and disadvantages with the current logistics agreement?

There are several areas where the consignment stock strategy implemented with the LA is successful. The LA decreases the lead time of the suppliers and increases their delivery performance. That, in turn, increases the availability that TPTS has to its customers, which is one of their main KPIs. Decreasing the lead time also decreases the stock levels kept by TPTS, which further decreases the cost, and ultimately improves the profitability. As order lines for LA materials constitutes a large fraction of the total amount of order lines, there is a leverage ratio for improvements. The internal stock keeping cost at Tetra Pak is 7,5 percent quarterly, and the cost of the LA per quarter is 0,088 percent of capital covered. It means that keeping the stock at the suppliers, is substantially cheaper than having the stock in the warehouse. Although the figures are only accumulative, and can only be verified to a certain extent, the gap in costs is still telling. TPTS are getting high availability with the LA, and they are getting it cheap.

Another area of strength is how the LA impacts relationships with the suppliers. The relationship is solidified with joint improvement activities and financial support from TPTS. The LA also complements their single-sourcing strategy, as they keep the advantages from single sourcing but decreases the risk of supply. It is ultimately a tool that entails continuous communication with the supplier. Investing in the supplier in this way creates loyalty which will benefit Tetra Pak in the long run.

The disadvantages with the LA are also present. The issue is to find the materials that benefit most of the consignment stock strategy. Currently, there are no tools that help that, which risks getting the wrong materials included in the LA strategy. When there is a limited categorization of materials because the data does not reflect the materials demand accurately, materials are included which does not benefit from the LA. Instead, they just add to the costs. The volatility of the scope and ASL are too high. Although the scope should be updated at intervals, it should

not be done not too frequently. Then the suppliers will not have time to build up stock as planned, and they are not able to get the benefits of adapting batch sizes and planning when to manufacture to reduce downtime for equipment. Updating the scope too frequently also causes non-compliance of the terms, as TPTS and the suppliers do not manage to follow up and update data correctly. Both the advantages and disadvantages are compiled in Table 7.1.

Table 7.1. Advantages and disadvantages with the current logistics agreement.

Advantages	Disadvantages
Short lead times, which in turn drives down stock keeping costs	High volatility of ASL scope. Partly because snapshots in time data are used
High levels of delivery performance	Varying forecasted ASL complicates the suppliers realizing benefits in planning their production and batch-sizes
High availability at a reasonable cost	Non-compliance for updating lead time on materials
Works as a tool to enhance the supplier relationships	No tools for selecting which suppliers should get an LA
Integrated with the overall purchasing strategy	Flawed categorization of materials with good data to identify the materials that benefit the most from an LA

The conclusion for TPTS with the current logistics agreement is that it is good and valuable. Keeping stock at the suppliers works in purchasing for the after-sales, as it reduces cost for the buying company while helping the selling company plan production better. The issue is to have the right materials included in the strategy, while at the same time keeping continuity, as too much change diminishes the advantages.

7.1.2 RQ2: How can the logistics agreement be improved in terms of scope and classification of spare parts?

There are two separate scenarios to decide how the logistics agreement can be improved in terms of scope and classification. Materials have to be categorized based on the data available, and the availability of such data is the deciding factor. Therefore, two separate models for improving the scope of materials have been created, see Figure 7.1.

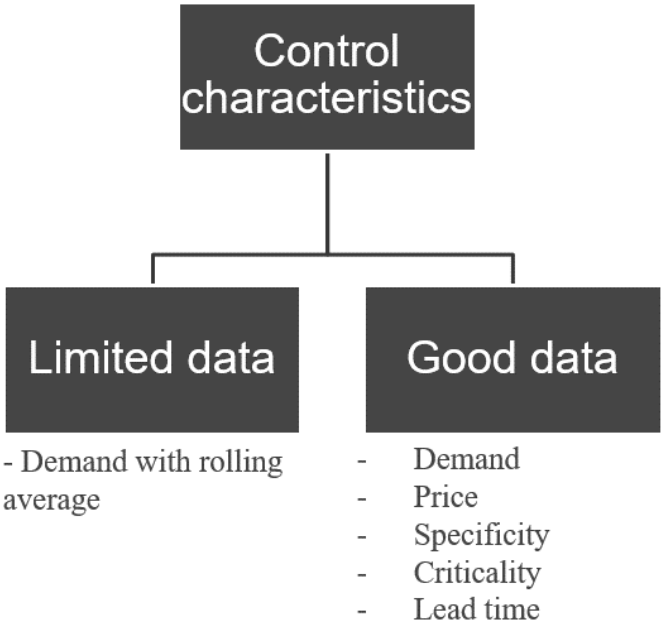

Figure 7.1. Two different methods of categorizing materials depending on the availability of data.

If only data regarding the demand is available, the focus should be to use the data to categorize parts in a way that best represents the nature of the part. It has been concluded that continuity is an essential factor to reap the full benefits and to get compliance from the suppliers. Therefore, should volatility of the scope be controlled. The solution should decrease the variance and keep the scope stable while at the same time including as many materials as possible that benefit from the strategy, as the cost of creating availability with the LA is lower than keeping it in stock. Based on the four alternatives in chapter 6.2.1, where different solutions was tested, the conclusion was to use a rolling average of three months, with biannual updates of the scope. Compared to the current solution, it increased the number of materials that were at all times included in the ASL, and it severely decreased the number of materials that jumped out and in. The conclusion is therefore that when data is limited, a solution should be selected that can with limited data create stability while at the same time reflecting the nature of the parts.

If data are available, the categorization should be based on several parameters to determine the scope. Beyond using demand, factors such as price, specificity, criticality, and lead time would be included. The advantage of this solution is that materials could be divided into different groups based on specific weights. Such a solution would enable a company to increase the availability of critical materials. Further, it would enable a possibility to not have to use a one size fits all solution. Using the lead time to determine materials in the scope and ASL could

further enable a buyer to support their suppliers in proportion to the risk they take on. It would give a fairer system and suppliers that deliver materials with long production lead time would get additional benefits. Ultimate, it would help to get high availability for any beneficial material to the lowest possible cost.

7.1.3 RQ3: How could a general model be formed as guidance for future logistics agreements?

It has been established that a solution such as the logistics agreement is beneficial in the after-sales. The issues that the case company Tetra Pak has experienced can, to a certain extent, be attributed to a lack of structure to implement the strategic direction. The model proposed in Figure 7.2 takes critical features from literature, comparative companies, and Tetra Pak, complemented with solutions to specific problems Tetra Pak has experienced. The main feature is to have a long-term strategic direction aligned with the overall strategy and create a setting where the supplier and buyer can work with continuity. The model proposed consists of five unique steps and is iterative to support continuous improvement.

(1) The first step of the general model is to decide what the overall goal with the strategy is. The most common goal for spare parts is increased availability, but also other KPIs such as delivery performance and lead time can be selected. The critical feature is aligning the strategy's goals with the overall goals of the business unit and to not sub-optimize. For example, determine that the agreement is a complete solution to avoid materials being affected by factors such as MOQ.

(2) Based on the goals set, materials are categorized into groups based on their control characteristics to create the appropriate logistics system. In this step, the categorization can be based on demand if there is no other data available. Then it is vital to select the demand on a rolling average to create stability and continuity. If there is data available, the parts can be categorized based on several features. That solution is desirable as it can map resource spend to impact, but hard to achieve as such data is not always accessible or integrated.

(3) After materials have been mapped, the suppliers should be selected. Based on the adapted Kraljic Matrix, suppliers that deliver materials with high-profit impact and high supply risk should primarily be selected because those types of materials will benefit the most from the investment that the strategy entails.

(4) The fourth step is to update the scope for set intervals. The key feature is to do the updates with an interval that balances continuity and compliance from the suppliers, with having an updated scope of materials that are the most beneficial for the strategy. In between updates, the scope should be locked to more accessibly facilitate check-ups and reviews.

(5) The final step of the process is evaluative. It should answer the question: "*Are we achieving our set-out goals?"* The performance of materials included in the strategy should be checked to see if it corresponds to goals. The KPIs can be used to see the performance of materials in comparison to materials outside the scope. If the suppliers are halting in performance, measures should be deployed to uncover the source of disruption. If the fault is not solved over time, the buyer should search for other alternatives.

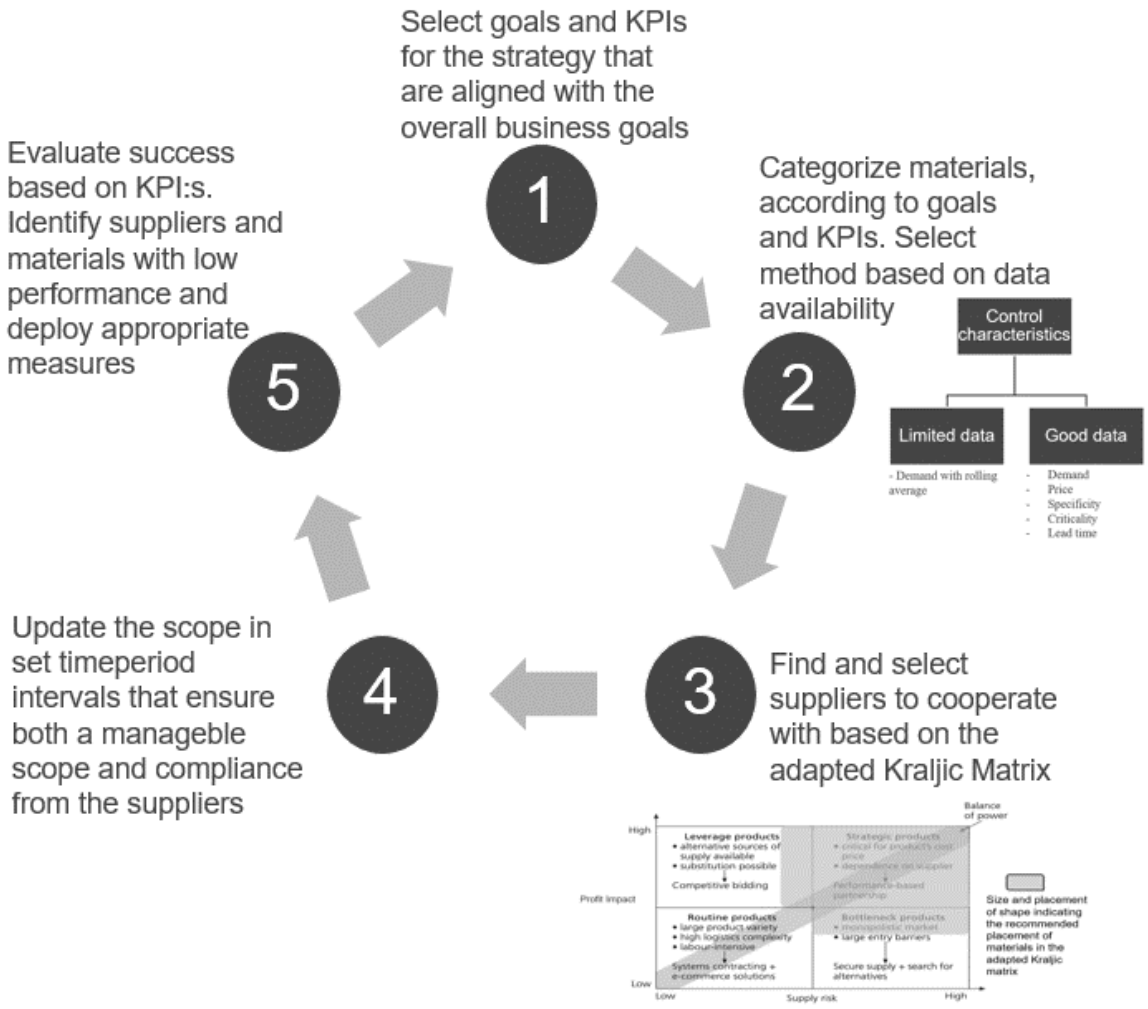

Figure 7.2. A general model in five steps for a logistics agreement in the buyer-seller dyad.

7.2 Contribution

The purpose of doing research is to take what is already known, validate it, and further develop it. To specify the contribution of the research is therefore an important subject. In this thesis, the contribution has been divided into contribution to theory and contribution to practice.

7.2.1 Contribution to theory

While after-sales services and especially for spare parts is a well-established research topic within academia, there is a gap when looking at the effect buyer-supplier agreements, like the logistics agreement, have on performance within the after-sales. As such, this thesis contributes to theory by establishing case-based findings regarding how a buyer-supplier agreement can impact KPIs for a supply chain engaged in spare parts sales. Further, it presents a general model for companies and other researchers to analyze other buyer-supplier agreements within the scope of after-sales service. The conceptual model can help with providing insights and strategic suggestions for how a company should set up their agreements with the supplier, highlighting important questions and areas to decide on regarding what materials should be in scope, to whom the agreement should be offered, and why an agreement should be offered. Further, the model developed from research question three is general and can be used by other companies when implementing a consignment stock strategy with similar terms as Tetra Pak.

The research also applies multiple past theoretical findings on a global company, somewhat testing their validity and applicability. Further, the thesis also presents and dissects a buyer-supplier agreement that can help future researchers find insights and examples that can be integrated into their research.

7.2.2 Contribution to practice

One of the main contributions of this thesis is towards PSC at Tetra Pak and the increased insight and understanding of the logistics agreement they have received. PSC will hopefully also benefit from the developed recommendations on how they can improve the performance of their current logistics agreement as well as a general model for how they can set up future editions of the agreement. The recommendations give an opportunity to smooth out some of the issues and disadvantages that were identified from the research while capitalizing on the strengths and advantages that were shown through literature and data analysis. Other companies working with the same issues can also use the findings of this thesis to improve their processes and strategic decisions regarding how they handle spare parts purchasing and management within their organizations. Finally, with this thesis and its conclusions, PSC has been given suggestions and guidance on how they can continue to work with their logistics agreement and proceed with developing it in the future.

One possible shortcoming of the thesis is that several ideas from literature could not be adapted to work for Tetra Pak, as they lacked the data and the technical capability to implement it. It could be argued that it would decrease the relevance of the thesis. However, Tetra Pak is a company with a general high capability, and their weaknesses are not just limited to them but are with high probability also present in other companies. Therefore, the solutions created within the scope of this project can be said to be more relevant for more companies than if they were based on perfect conditions, as it contributes to creating solutions that more companies can use.

7.3 Further research

During the research for this thesis, a couple of interesting topics arose that the authors could not investigate due to the time constraint of the thesis. These topics could be suggestions for future research that would also strengthen some of the findings presented in this thesis.

As the findings and recommendations of this thesis are focused on Tetra Pak, specifically TPTS, it would be interesting to test these on other companies to investigate the generalizability and applicability. It could give insights into whether there are different outcomes due to factors such as the company's size, the industry operating in, and position in the supply chain. The conceptual model for analysis (Figure 3.8) brought forward in this thesis would also benefit from being applied in other organizations. Tested in other situations, it would enable peer-reviews and a possibility to develop the model further. It is also of interest to research whether the conceptual model can be applied to agreements for other products than spare parts. While many of the areas in the model are of interest in traditional supply chains, Cohen et al. (2006) showed that the supply chain for spare parts acts differently than traditional supply chains, and therefore, the applicability of the model cannot be taken for granted.

Two significant areas for PSC that the authors would have liked to look into further if having the time are those of implementation within the company and optimization of parameters for the ASL scope. The first is based on the fact that Tetra Pak is a large organization with many different divisions. The logistics agreement is today only used by TPTS. However, Tetra Pak has similar solutions for buyer-supplier agreements developed in other business units. Researching and testing the realized results and implications would be from implementing the logistics agreement across the whole organization is of interest to Tetra Pak. Further, it would be of interest to see the synergies when deploying it across the whole organization. Second, due to a lack of available data at the time, the researchers could not test the optimal values of the parameters segmenting materials for the ASL scope. A study that would gather the necessary data and compute which values of the parameters give the best selection of materials that fall under the ASL scope and logistics agreement would give the practical research on how to implement material categorization with multiple parameters.

It would also be of interest to investigate what the technological advances in manufacturing may have for effect on the studied topic. Manufacturing of spare parts through 3D printing is in the development stages today and researching how possible implications would affect the necessity of consignment stock agreements could be interesting. It could also give insights into what the supply chain of spare parts will look like in the future.

Lastly, one area widely present in the discussion and strategic decision-making worldwide is the environmental impact. This thesis has not tested what effect the logistics agreement, or buyer-supplier agreements in general, has on the environment. A hypothesis is that it reduces unnecessary transports, as the material is only purchased when needed. Answering the question of if there is a net benefit for the environment from using a logistics agreement could give further insights into the logistics agreement's value.

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9 Appendix A – Interview Guide Suppliers

Open Questions

Can you describe what your company does?

Can you please describe your role?

Who are your customers?

How long have you worked with Tetra Pak Technical Service?

How do you work with Tetra Pak Technical Service?

Is Tetra Pak Technical Services a standard customer to you or are they prioritized in any way

1. **What is the current logistics agreement, how does it perform in regard to the stated goals behind the formation of the agreement and what issues are present?**

What is your present knowledge about the logistics agreement (LA) and assigned stock level (ASL)?

How do you work with the logistics agreement?

How much time do you spend weekly as an effect of the logistics agreement?

What is your level of understanding in regard to the LA?

What is the difference between how you work with material covered by the LA compared to materials that are not?

Are you comfortable with keeping extra stock for Tetra Pak?

Do you feel that the logistics agreement is a security for you?

Does the logistics agreement affect your production batches?

Is material stock holding cost a substantial factor?

2. **What should be the scope of a logistics agreement and is there a way to classify spare parts in order to help reach the goals of a logistics agreement?**

What factors do you look at when deciding there is a need for a logistics agreement to be able to meet the demand from Tetra Pak.

What factors need to be considered for you to achieve the lead time and delivery performance that TPTS asks of you?

What similarities and differences are there with the LA-solution compared to how you work with other customers?

Is there a separate work methodology depending on the products?

3. **With today's perspectives and knowledge, how would a company constitute a model trying to solve the solutions targeted by the present logistics agreement?**

What differences would you like to see in the LA?

When and what resources are needed for you to deliver at 96% and 14 day lead time on requested products by TPTS?

What need is there for a risk-sharing solution?

10 Appendix B – Interview Guide Comparative

Open Questions

Can you describe what your company does?

Can you please describe your role at the company?

1. **Internal Processes/(Spare) Parts Purchasing**

How does your company work with ensuring availability of (spare) parts for after-sales/production?

What is the internal process that transpires when a customer makes a request for a (spare) part?

When you make a purchase for a (spare) part from your suppliers, what are the stages of the purchasing process?

What kind of information do you share with your suppliers outside of purchase orders?

2. **(Spare) Parts Management**

Which KPIs do you deem as the most important for (spare) parts purchasing?

How do you work to achieve high delivery performance from your suppliers?

How do you work to achieve short lead times from your suppliers?

Does your company follow a "philosophy" regarding stock management for (spare) parts?

Do you have a way to classify (spare) parts into different segments, and if so, how does the classification work? (i.e., criticality/high runners/etc.)

Do you use (spare) parts classification in your purchasing and stock handling process?

3. **Supplier Collaboration**

Do you have different ways of working with (spare) parts suppliers?

How do you measure the performance of your suppliers?

If a supplier is underperforming regarding your KPIs, what actions do you take?

Are there situations where there is a need for a risk-sharing solution between you and a supplier?

What are the most important aspects that such a solution should contain?

If you were to look 10 years into the future, what will be the success factors for good supplier collaboration? What are the success factors today?