Improving the packaging material availability for internal testing

A case study at Tetra Pak

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Abstract

Title: Improving the packaging material availability for internal testing - A case study at Tetra Pak

Keywords: Supply chain management, process mapping, procurement, visibility, order handling, supply chain information systems.

Background: For any business, optimizing the supply chain is beneficial and can be a crucial competitive advantage. Additionally, the significance of optimization is even greater for the elements that are most essential for one's business offering and value creation. An essential element in the business offering at Tetra Pak is the internal testing required to develop and deliver high quality processing and packaging solutions. It has been identified that there are improvement areas in this process. A deeper understanding of the current process is desired, to evaluate and improve the process.

Purpose: The purpose of this thesis is to improve the coordination of packaging material for internal testing at Tetra Pak.

Research questions: To improve the current setup and coordination of packaging material for internal testing, the following research questions have been answered:

- How does the current process of coordinating packaging material for internal testing look like?
- How can the efficiency of the coordination of packaging material for internal testing be increased?
- How can the performance of the coordination of packaging material for internal testing be measured?

Method: This study is based on a single case study where the coordination of packaging material for internal testing is the unit of analysis. The project has a predominant focus on a deductive approach since existing theory has been reviewed to investigate the phenomenon. Qualitative and quantitative data is collected to then be structured and analyzed through performing a Makigami analysis.

Conclusion: The Makigami analysis has visualized the process including responsible functions, where they are operating in the process, and respective functions needs. The entire process is complex with many exceptional cases and where the outcome varies depending on the situation. Commonly, there are shortcomings in collaboration, a lack of training materials throughout the process and a lack of understanding between the functions involved and their individual work process.

It is concluded that several improvements could be possible by redesigning the process. To combat this issue, the analysis yielded, in general, six recommendations to follow:

- Implement instructions and training material.
- Increase the visibility of the process.
- Increase communication and collaboration.
- Improve the accuracy of information in the currently used information system.
- Give functions concerned access to relevant information.
- Implement a comprehensive KPI system, forecasting and create a drop-down list for existing variation of information.

Contribution: This thesis has been a complete elaboration between the two authors. Each author has been involved in every part of the process and contributed equally.

Sammanfattning

Titel: Förbättra tillgängligheten av förpackningsmaterial för intern testning – En fallstudie på Tetra Pak.

Nyckelord: Logistik i försörjningskedjor, processkartläggning, upphandling, synlighet, orderhantering, informationssystem för logistik och försörjningskedjor.

Bakgrund: För alla företag är det fördelaktigt att optimera leveranskedjan, vilket även kan vara en avgörande konkurrensfördel. Dessutom är betydelsen av optimering än större för de element som är mest väsentliga för ens affärserbjudande och värdeskapande. En väsentlig del av Tetra Paks affärserbjudande är de interna tester som krävs för att utveckla och leverera högkvalitativa process- och förpackningslösningar. Det har identifierats att det finns förbättringsområden i denna process. En djupare förståelse för den aktuella processen önskas för att utvärdera och förbättra processen.

Syfte: Syftet med detta examensarbete är att förbättra koordineringen av förpackningsmaterial för intern testning på Tetra Pak.

Forskningsfrågor: För att förbättra den nuvarande processen och koordineringen av förpackningsmaterial till intern testning kommer följande forskningsfrågor har besvarats:

- Hur ser den nuvarande processen ut för att koordinera förpackningsmaterial till intern testning?
- Hur kan effektiviteten i koordinering av förpackningsmaterial till intern testning ökas?
- Hur kan prestandan för koordineringen av förpackningsmaterial till intern testning mätas?

Metod: Denna studie är baserad på en enskild fallstudie där koordineringen av förpackningsmaterial till intern testning är analysenheten. Projektet har ett övervägande fokus på en deduktiv ansats, eftersom befintlig teori har andvänts för att undersöka fenomenet. Kvalitativa och kvantitativa data har samlats in för att sedan struktureras och analyseras genom att utföra en Makigami analys.

Slutsats: Makigami analysen har visualiserat processen inklusive ansvariga funktioner, var de är verksamma i processen och respektive funktionsbehov. Hela processen är komplex med många undantagsfall och där utfallet varierar beroende på situationen. Vanligt förekommande i processen är brister i samarbete, brist på utbildningsmaterial över hela processen och bristande förståelse mellan de inblandade funktionerna och deras individuella arbetsprocess.

Flera förbättringar är möjliga genom att designa om processen. Analysen av problemet gav generellt följande sex rekommendation:

- Implementera instruktioner och utbildningsmaterial.
- Öka processens synlighet.
- Öka kommunikation och samarbete.
- Förbättra noggrannheten i informationen för de informationssystem som för närvarande används.
- Ge berörda funktioner tillgång till relevant information.
- Implementera ett omfattande KPI-system, prognostisera och skapa en rulllista för befintlig informationsvariation.

Bidrag: Detta examensarbete är resultatet av ett samarbete mellan författarna. Båda författarna har varit med i alla delar i processen och bidragit till lika delar.

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List of abbreviations

AddMat – Additional material

BSC – Balanced Scorecard

B2C – Business-To-Customer

CF – Converting Factories

CSP – Case Study Protocol

D&T – Development and Technology

ERP – Enterprise Resource Planning

ETA – Estimated Time of Arrival

IT – Information Technology

KPI – Key Performance Indicator

MDM – Master Data Management

MOQ – Minimum Order Quantity

MRO – Maintenance, Repair and Operation

PackMat – Packaging Material

PR – Purchase Requisition

RFI – Request For Information

RFP – Request For Price

SCM – Supply Chain Management

SCO – Supply Chain Operations

SCOR - Supply Chain Operations Reference

SOP – Standard Operating Procedure

TOMS – Test Order Material Service

TPI – Tetra Pak International

TPS – Toyota Production System

VAT – Value Added Time

WIP – Work In Progress

WMS – Warehouse Management System

1. Introduction

This chapter presents the background for the project with the corresponding problems and purpose. The chapter continues with clarifying delimitations and at last illustrates the outline of the thesis.

1.1 Background

Supply Chain Management (SCM) covers the handling of the entire production life cycle of a good or service, from raw components to delivery of the final product to customer. For any business, optimizing this handling is beneficial and can be a crucial competitive advantage. Additionally, the significance of optimization is even greater for the elements that are most essential for one's business offering and value creation. (Mentzer et al. 2001)

For Tetra Pak to provide their offering to customers, the element of performing the internal testing is crucial. Internal testing is an important part in the development process of producing new packaging and processing solutions. Successful execution of product development is important to implement as it is essential for a business to remain competitive in the market (Chen et al. 2008). Additionally, internal testing is accomplished of complete machines, before delivering to external customers. Ensuring high quality is valuable and aligned with the overall purpose of the company of making food safe and available for everyone. Further, ensuring high quality is a strong driver of profitability and overall performance (Cooper and Kleinschmidt 2007).

The initiation of this study is based on the identified need to deepen the understanding and improve the process of coordination packaging material for internal testing. Conducting this study is significant for the company to improve the vital process which enables the company to perform the valuable activity of internal tests.

In SCM, there is broad knowledge on how processes can be optimized, which has been applied to provide relevant and academically supported recommendations to the specific case company. However, based on current research, there are identified gaps in literature. Firstly, there is little empirical evidence of actual benefits arising from SCM (Naslund and Williamson 2010; Stock et al. 2010; Lambert et al. 2005). Further, it can be difficult for practitioners to navigate within the concept of SCM and find applicable and concrete frameworks for one's specific business. For example, the lack of a commonly accepted framework within the concept results in difficulties regarding how SCM should be implemented and measured. (Naslund and Williamson 2010; Burgess et al. 2006; Mentzer et al. 2001; Stock and Boyer 2009) Additionally, a gap has been identified in literature connected to procurement since there is a predominant focus on external procurement. The internal processes, which are in scope of this study, are not emphasized. This study thus aims to bring clarification for the company and practitioners on a general level to counteract literature limitations. This clarification aims to include how to use SCM to improve a process, emphasizing the internal perspective.

1.2 The case company

Tetra Pak is a global company with a complex supply chain consisting of several value-adding activities that are crucial for their offering. Below, Tetra Pak's history and offering are presented. Further, the specific value-adding activity of testing is explained, which constitutes the specific part of the Tetra Pak's supply chain that this report aims to focus on.

1.2.1 Tetra Pak's history

Tetra Pak is a company that develops and produces processing and packaging solutions for food and beverages. The journey first began when the first tetrahedron-shaped carton was developed. The solution, combining minimal usage of material while simultaneously providing maximum hygiene, was to be an alternative for the heavy glass bottles then used to package and distribute milk. The new solution required crossing barriers within construction of machines for packaging. Since the start, when Ruben Rausing founded and established Tetra Pak in Lund, Sweden, the company has continued to cross barriers and provide innovative solutions on a global scale (Tetra Pak 2021a). Today, Tetra Pak is a multinational company with over 25 000 employees and one of the largest suppliers of complete packaging systems. The solutions meet the needs of millions of people every day, in more than 160 countries. (Tetra Pak 2021b)

1.2.2 The offering

At Tetra Pak, the focus is to develop solutions and technologies required to ensure safe food. The solutions that are provided more specifically include integrated processing, packaging and distribution line and plant solutions for liquid foods and manufacturing. Regarding processing solutions for food and beverages, Tetra Pak offers processing applications and equipment. The growing range of applications are customizable to fit the customer demand and can be applied to dairy, cheese, ice cream, beverages, and prepared food. Regarding packaging, Tetra Pak offers complete carton packaging for customization of food products. The packaging portfolio is presented in Figure 1-1 below.

Figure 1-1: Tetra Pak's packaging portfolio. (Tetra Pak 2021c)

Regarding services, Tetra Pak offers services aimed at improving performance, optimizing costs and ensuring food safety throughout operations. The service offer is tailored and can, for example, include repairing and preventing breakdowns and updates. However, every aspect of the production of food, from daily operations to business insights, can be covered (Tetra Pak 2021c).

1.2.3 Packaging material for internal testing

To deliver solutions and technologies that ensure safe food, internal testing is a crucial element within the value creation at Tetra Pak. Today, internal testing occurs on multiple Tetra Pak sites globally and for different purposes. To be able to perform internal testing, diverse types of packaging material are needed. The needed packaging material can be divided into two categories: Packaging Material (PackMat) and Additional Material (AddMat). PackMat is equivalent to different forms of carton material and AddMat is equivalent to additional material used in the packaging, such as plastic granulate, straws, strips, and caps. Hereafter, when describing all packaging material, both PackMat and AddMat, this is mentioned as *packaging material*.

A simplified process of coordination packaging material for internal at Tetra Pak is illustrated in Figure 1-2 below.

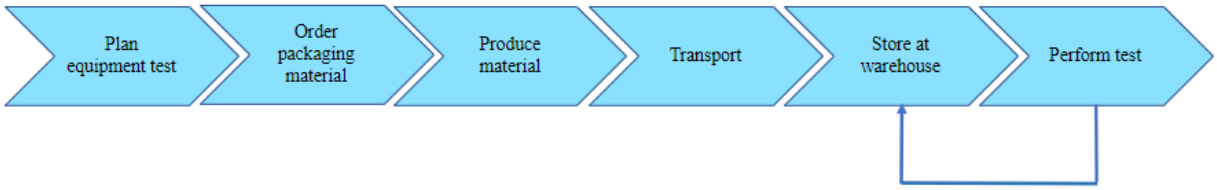

Figure 1-2: The simplified process of coordination packaging material for internal testing at Tetra Pak. (Own illustration)

Packaging equipment tests are planned, and packaging material is then requested by internal clients at Tetra Pak. Orders are then handled and packaging material is produced by Tetra Pak themself in their Converting Factories (CF), located globally. Thereafter, the goods are shipped to internal clients to be stored at a local warehouse before testing is performed. If packaging material remains when the test is complete, it is sent back to the warehouse to be used for testing packaging equipment of the same type. If the packaging material is not used within the expiry date, it cannot be used for testing and is scrapped.

A functioning coordination of packaging material is vital to ensure that the material arrives on time for testing. This in turn is important in keeping the delivery date to clients and to support the development projects internally at Tetra Pak. To fulfill this test material demand, several functions within the company must collaborate. Table 1-1 below illustrates the main functions involved in the process, from placed order to finished delivery. The main purpose of each function is also described.

Table 1-1: The main functions involved in the process of coordinating packaging material for internal testing.

Function	Purpose
Client	The requestor of the packaging material executing the internal test.
TOMS (Test Order Material Service)	Procurement coordinators who manage the requests and orders of packaging material for internal tests.
Planning leader	Confirm order over a certain amount for production.
Tetra Pak International (TPI)	Creates and pays standard orders for packaging material.
CF	Produce and store test material before departure to the client. Can execute internal testing on site if requested by the client.
Design HUB	Supports clients in creating new packaging designs for printing.
Material and capacity planners	Check material availability for production of packaging material.
Supply chain control tower	Arrange external delivery from CF to client.
Master Data Management (MDM)	Maintenance of system and updates master data connected to packaging material.
Coding and specifications	Maintenance and extension of codes for packaging material (such as creating new codes for orders of material not available within the current database).
Custom clearance	Service in connection with exportation and importation.
Supply coordinator	Coordinate deliveries of packaging material.
Warehouse	Stores the finished goods before internal testing is executed.
Transport	Performs delivery from CF to the local warehouse and from local warehouse to client site.

All functions are subject to various levels of influence in the process, depending on the type of test material requested by the client. However, the collaboration between the functions involved is important to coordinate packaging material for tests.

1.3 Problem

At Tetra Pak, there is a need to ensure that the flow of packaging material for internal testing works efficiently. Historically, the company has made efforts to improve the coordination. To address problems, a test order process was created to simplify the order flow for the internal market companies. The centralized team of TOMS was created in 2018 to reduce the amount of time that engineers put into making an order. In addition to placing the actual order of packaging materials, they have a significant role in the entire handling of an order. From the moment a request is received until the material arrives at the client site. TOMS thus acts as a connecting function, whose purpose is to create a smooth flow during order processing, connecting all involved functions.

Even with the creation of the centralized team TOMS, there is a high effort on coordination with several interfaces and handovers. There is a desire to follow the standard process to better pulse

and track orders to secure deliveries of packaging material for testing. Today, difficulties lie within handling the flow when several functions are involved. Functions that are often located geographically in different parts of the world, which makes smooth collaboration difficult. Additionally, stakeholders involved express loss of information and knowledge in the process, as well as waste of packaging material. Lastly, the actual performance of the process linked to the coordination of packaging material for testing is often not measured. However, the process of commercial testing is something that is measured to a greater extent.

To ensure that the flow of packaging material for internal testing works efficiently, there is a desire to first gain a deepened understanding of the current flow. Additionally, a deepened understanding is described to be gained through a clarification of which functions are involved in the process, as well as how different functions are connected. Due to the large amount of testing carried out internally, it is also difficult to create an understanding of who orders material for testing through TOMS, and for what purpose. By creating an understanding of the current process, there is a belief that gaps can be identified and eliminated to develop the process to be executed in a more efficient way. Furthermore, there is a desire to determine how a potentially improved process can be maintained through using appropriate performance measurements.

1.4 Research purpose and questions

The purpose of this thesis is to improve the coordination of packaging material for internal testing at Tetra Pak. To improve the current setup and coordination of packaging material for internal testing, the following research questions have been answered:

- How does the current process of coordinating packaging material for internal testing look like?
- How can the efficiency of the coordination of packaging material for internal testing be increased?
- How can the performance of the coordination of packaging material for internal testing be measured?

1.5 Focus and delimitations

As mentioned earlier, Tetra Pak is one of the largest suppliers of complete packaging solutions. This generates a complex supply chain with several departments, functions and processes spread globally. This study is limited to internal testing and its connection to the coordination of packaging material. All other activities in the company which are not connected to this process are excluded in this study. This is illustrated in Figure 1-3 below, where the two orange circles present where in the supply chain internal testing occurs.

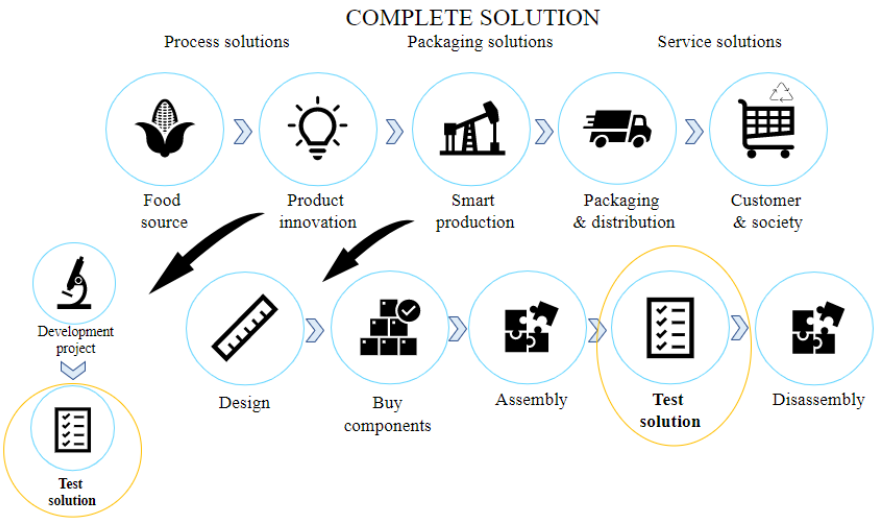

Figure 1-3: A simplified illustration of Tetra Pak´s supply chain. (Own illustration)

To perform internal testing at Tetra Pak a number of factors are vital, where packaging material is one of them. There are a number of components that are significant for testing in addition to packaging material, such as the machine itself. However, components other than packaging material have not been investigated in this study. The internal factories producing the packaging material are the ones responsible for the procurement of all raw material needed to produce new packaging material. The procurement of raw materials to produce packaging material in internal factories is excluded in this study. Additionally, the actual process of testing is also excluded. Worth mentioning, after the machine has been installed at the market customer, external tests are performed with the customer's own packaging material. Consequently, this part has not been investigated since the focus of the study includes only the coordination of packaging material for internal testing.

Within the coordination of packaging material for internal testing, there is a predetermined number of CF to choose from. These factories are internal collaborators. This means that there is already an agreement between the clients and the factories producing the packaging material. Hence, the sourcing strategy including negotiation and contracting with new CF are excluded in this study.

All the relevant stakeholders presented earlier in the chapter are involved and included in this study. All perspectives are to be collected to present a broad picture of the current process. Due to the high number of functions involved and number of belonging employees, only a few representatives were selected from each function. However, every selected representative was carefully chosen regarding how strong the connection was to the process in study. For example, there has been a selection of data input from clients where those who order material most frequently have been a source of more relevance when analyzing the process.

Furthermore, the study was limited to only focusing on the orders going through the internal team TOMS. Tetra Pak is a global company and internal testing takes place in several locations around

the world. TOMS, on the other hand, is a team that is limited to handling orders from specifically four sites. Thus, the study has a focus on clients located at sites ordering through this process. The departments and functions ordering packaging material through another process have not been investigated in this study.

Beyond the delimitations mentioned, the timeframe has also been a limiting factor to keep in mind. Consequently, planning and prioritizing have been important parts of the study to complete the data collection, achieve the purpose and answer the research questions of the thesis within the set timeframe. In the method for carrying out the study, Makigami analysis has been a central tool. Only the steps relevant to answer the research questions of this study have been selected. These are the steps that aim to map the current process, identify shortcomings and develop an improved process. The tool can also be applied to implement the process, which are steps that this study excludes.

To clarify the mentioned focus and delimitations, the orange circle in Figure 1-4 illustrates and summarizes the scope of the study.

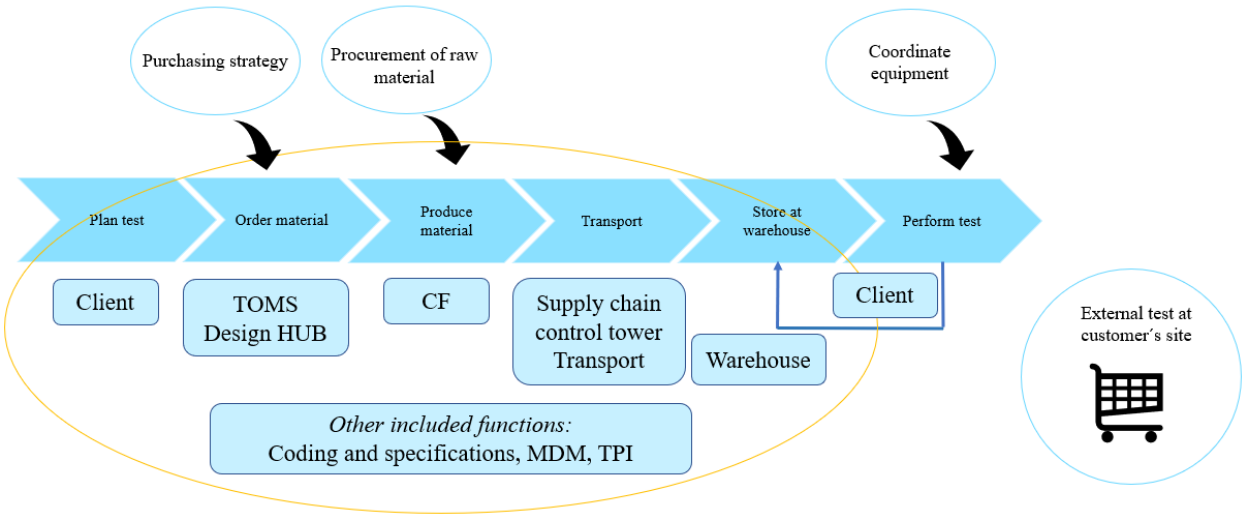

Figure 1-4: Illustration of focus and delimitations of the study. (Own illustration)

1.6 Target audience

This thesis is directed to Tetra Pak, and specifically the functions involved in the process of coordinating packaging material for internal testing. This is due to the thesis focus to aid these functions with process insights and strategic recommendations for improvement. Further, this study is directed to the academic audience at the Division of Engineering Logistics at Lund University. Specifically, the Division of Logistics, since the study's purpose is to finalize the author's studies within engineering. The thesis also aims to offer valuable theoretical findings at a general level. Hence, the report may also be interesting to other organizations.

1.7 Outline of the thesis

Chapter 1: Introduction

Describes the background for the project with the corresponding problems, purpose and expected results. The chapter continues with clarifying delimitations and at last illustrates the outline of the thesis.

Chapter 2: Methodology

Explains how the project has been executed and what reasoning lies behind these decisions. The chapter includes the sections: research approach, research strategy, data collection and data analysis. To conclude the chapter, the credibility of the thesis is discussed.

Chapter 3: Literature review

Presents the relevant and applicable literature for this case study. This chapter aims to create an understanding of key concepts and existing knowledge. Additionally, gaps in literature within the frame of reference are identified. The chapter includes relevant and applicable theories that help provide solutions and credible recommendations.

Chapter 4: Empirics

Presents the results of the study. The current process of coordinating packaging material for internal testing is first illustrated and described with the Makigami map. The information systems used in the mapped process are also presented. Further, identification of client, including their ordering purpose, is presented.

Chapter 5: Analysis

Provides an analysis of the results generated from this case study. The structure of this chapter is similar in structure to the previous chapter. The chapter thus consists of analysis of the following main topics: logbook, Makigami, information systems and performance measurement. Analysis of order templates is woven into the Makigami section as it is linked to the description of the work processes. To compile the analysis and provide a basis for the recommendation in the following chapter, the solutions are analyzed based on an impact effort matrix.

Chapter 6: Conclusion and recommendations

Provides the appropriate recommendations for the case company based on the analysis of the results. The recommendations and conclusions connected to each research question are first elaborated on. Thereafter, the contribution of this study is presented, as well as limitations and future research.

2. Methodology

This chapter of the report explains how the study has been designed and conducted to address the purpose and answer the research questions. The chosen methodology, and what reasoning lies behind the decisions, are elaborated on in the sections: research approach, research strategy, data collection and data analysis. To conclude the chapter, the credibility of the thesis is discussed.

2.1 Research strategy

In this section, the unit of analysis for this study is defined. Based on this, the strategy of performing a case study is motivated. A case study is an empirical method aiming to investigate a contemporary phenomenon, the concept being studied. (Yin 2014) The phenomenon is the coordination of packaging material for internal testing, where the thesis aims to describe why waste in this process occurs and how increased efficiency can be achieved. Waste correlates to parts in the process without adequate return (Makigami Methodology 2021).

2.1.1 Unit of analysis

The unit of analysis is vital for the selected research strategy and is identified based on the research question. The selected questions determine the focus and boundaries of the study. The unit of analysis can be an organization or part of an organization. In addition, it can also refer to a specific incident or event. That is, the entity that frames what to investigate in the study. (Fitzgerald and Dopson 2009) In this thesis, the unit of analysis is the functions included within the Tetra Pak supply chain that affect the flow of packaging material for internal testing. More precisely, it includes all functions affected throughout the process, presented earlier in the introduction chapter in Table 1-1. This study contains only one unit of analysis and is thus called holistic, unlike a study with more than one which is called embedded (Yin 2014). For this study, this is a suitable unit of analysis as it ensures that all relevant processes are covered. When all relevant functions are analyzed, a good basis for answering the study's research questions is provided.

2.1.2 Single case study

A single case study is the selected research strategy applied to analyze the unit of analysis and answer the research questions. This strategy is suitable to apply since it is an in-depth and contextual investigation, which is required to understand this real-world case (Yin 2014). The observed phenomenon was described and explained through applied research. Due to the importance of context, any fact relevant to the stream of events describing the phenomenon can be a potential source of evidence (Leonard-Barton 1990). Further, case study research is applicable since the thesis aims to explain contemporary circumstances, “why” and “how” the phenomenon works. Further, it is suitable to apply for cases where the descriptions of a phenomenon are

focusing on details, where observation and systematic interviewing often are included in the method (Yin 2014). A selected method which is further elaborated on later in this chapter.

To successfully perform case study research, Yin (2014) claims that traditional concerns must be addressed to be avoided. The research must be conducted rigorously to ensure systematic procedures. Further, this allows for the ability to produce a comprehensive and structured report. In addition, the comparative advantage of a case study must be understood and confusion with non-research case studies must be avoided. Lastly, in many cases, it is difficult to draw general conclusions from the findings since it focuses on the examined case. A great benefit of the single case study is that it contributes to an in-depth study of the specific case, it however can limit the level of generalizability. Hence, it can be difficult to draw conclusions from a broader perspective. Therefore, rather than extrapolating probabilities, a suitable goal for the study is instead to expand and generalize theories.

2.2 Research approach

The research approach concerns the selection between an inductive or deductive approach. Deductive and inductive logic arise as mirrors of one another where inductive theory builds upon cases producing new theory from data, while deductive theory uses data to test theory (Eisenhardt and Graebner 2007).

Within the case phenomenon, coordination of the procurement process, there are existing relevant theories that have been applied to investigate this specific case. The project hence has a predominant focus on a deductive approach since theory has been reviewed to investigate the phenomenon. With a deductive approach, the expectations of reality work as a starting point. These expectations are based on previous theories and findings and are appropriate when there is much knowledge about the studied phenomenon. An inductive approach, on the other hand, is applicable when the knowledge of the concept or phenomenon is limited, which is not the case for the chosen phenomenon. (Jacobsen 2002) Rather, current theory within the field has been a crucial part in examining the specific case.

The subject is well-studied and hence previous theories and findings have been highly valuable to contribute with relevant and supported recommendations for the company. However, a purely deductive approach is difficult to obtain since there are no comprehensive theories about the phenomena applied to the specific circumstances and conditions at Tetra Pak. Additionally, limitations in literature concerning difficulties in navigating within the field has been identified. Further, the deductive approach explains, predicts, and controls the studied phenomenon but might overlook important aspects or information connected to the problem. This might happen if the researcher only searches for information that the researcher believes to be relevant to support the expectations. The risks of missing valuable information are avoided with an inductive approach. Instead of expectations, all relevant information is collected by observing the phenomenon in its natural setting. The collected data is later processed to deeper understand the core of the phenomenon, from detailed sections to more general perspectives. (Jacobsen 2002) The mentioned

aspects implies that an inductive approach is beneficial in combination with the deductive approach to create a greater degree of openness when searching for information.

2.3 Research design

Based on the strategy that has been determined, an overall design of the study is formulated with a description of the different steps and activities. By dividing the process into six steps, Yin (2014) outlines a reliable and trustworthy method for conducting case study research: plan, design, prepare, collect, analyze, and share. Figure 2-1 is included below, which aims to visualize the different steps and how they are connected.

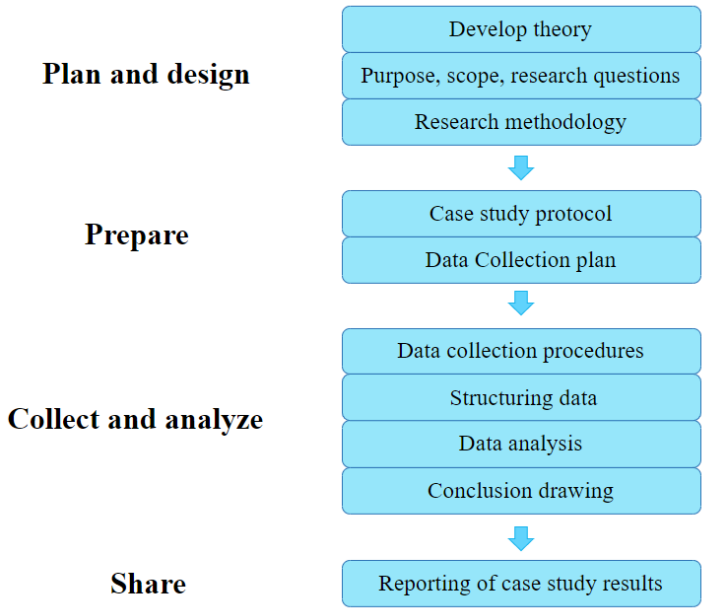

Figure 2-1: The process of the performed case study. (Own illustration adopted from Yin (2014))

2.3.1 Case study protocol

During the data collection process, the Case Study Protocol (CSP) provides guidance to the researcher to ensure the study's reliability. Research preparation is made easier with this tool, since it forces the researcher to anticipate issues before they arise and to stay focused on the study's purpose. (Yin, 2014). To prepare the researchers for the data collection process and develop a structure and purpose for the data collection, a comprehensive CSP was created before the data collection began, based on Yin (2014). An excerpt of this CSP is included in Appendix A of this report.

2.4 Data collection

The following section describes the data collection needed to execute the selected research approach.

2.4.1 Quantitative and qualitative data

In data collection, one can gather quantitative or qualitative data. Qualitative data is often in the form of words, which allows for interpretation, individual understanding, and nuances. Due to this approach, information gathering should not be predetermined. (Jacobsen 2002) In contrast, quantitative data can be calculated and classified, hence useful when there are few nuances to consider and when measuring predetermined information gathering. (Rahman 2020).

This project is based on a predominant deductive approach, where deepened understanding of the processes included in the coordination of packaging for internal testing is desired. To achieve this, nuances regarding the perspective of all stakeholders must be considered. These nuances are collected through qualitative data, which corresponds to most data gathered in this project. Further, some processes have been evaluated by gathering performance data, such as lead times and order history, hence quantitative data have been collected. Therefore, to gather all relevant information, quantitative and qualitative data have been required. To not share any sensitive data, all numerical data presenting in chapter four, *Empirics*, are multiplied with a confidential factor X.

2.4.2 Primary data

Primary data constitutes most of the information gathered from Tetra Pak throughout this project. The characteristic of primary data is that the information is from the primary information source (Jacobsen 2002). The methods used to gather primary data are interviews and observations.

Interviews

A main source for information gathering is interviews. Conversations were coordinated with the goal of obtaining the information needed. Respondents were stakeholders involved in the coordination of packaging material for internal testing. The respondent's role was not to handle the encounter, but to share information based on their experience. The interviewee was responsible for keeping the interview and respondent on track.

Participants were selected for interviews based on whether they are involved in the unit of analysis, that is, individuals who hold roles that affect, or are affected by, the flow of packaging material for internal testing. However, for each function, a few representatives were selected to account for the whole function. Those representatives were partly recommended by Tetra Pak´s internal function TOMS as being suitable to represent each function and as most relevant to the affected processes. Additional representatives were added after new insights from the interviews and after analyzing and evaluating order history through TOMS. Even though there are limitations in the number of perspectives, limitation is balanced by the selected respondents experience in the area.

More extensive information about the selected participants, their roles in the process and the interview plan can be seen in Appendix B.

A major part of the empirical data has been collected through interviews. To ensure that an accurate picture is conveyed, all information has been processed. When uncertainties arise, due to respondents' lack of either information or a comprehensive picture, the question has been brought up to one or several other-directed people. Throughout the project, observations and conclusions have been reviewed by key informants at Tetra Pak to align and discuss the results.

To conduct a successful interview, it optimizes the perceived communication objectives of the participants involved, with time as the main constraint. Further, proper preparation must be performed to have an outline for guidance, whereas too much planning can be equally detrimental. This may increase the risk that the interviewee develops conventionally correct answers, thus reducing the interview's value. In addition, the right questioning techniques should be applied, where questions are open, and the interviewee feels comfortable answering them. (Gubrium and Holstein 2001)

The basic outline for the used interview guide is presented in Appendix C. This guide was aligned before each interview to receive the most of each interview session. This was necessary since every function, and every interviewed person, had separate roles and responsibilities. The interview guide was sent out before the interview to clarify the purpose, touch on privacy concerns and to ensure that the person involved gets the opportunity to prepare if they so wish. This is necessary to create comfort and understanding of the interview's purpose, increasing relevancy to the scope.

During the interview, the questions asked were ensured to be open-ended questions to increase the value of the interview. At the same time, there was a clear structure to ensure all relevant data was collected. Since there was a clear plan and structure, the questions were predetermined in both topic and order. Structured interviews were chosen since they increase the chance of getting relevant information and allow comparisons of participant answers and hence increase the validity. As a result of structuring, the risk of asking leading questions, which could lead to observer bias, was reduced. The participants, however, were encouraged to clarify, elaborate, or rephrase their responses, if necessary, to ensure detail and richness which can be lost through a highly structured approach. (Rowley 2012)

Supplementary email

In addition to interviews, several emails were sent out to additional clients. Since there are many clients ordering packaging material for different purposes, this was necessary to reach most of them within the study’s time. The emailed questions had similarities to the interview guide with the desire to understand the purpose of ordering. The used email can be found in Appendix D. When no answer where received, the questions were asked to key informants within the TOMS function instead.

Observations

To supplement the primary data from the interviews, several activities within the process of coordinating packaging material for internal testing have been observed at the site in Lund. Investigators have conducted direct observation when they visit the site to collect data for this case study. Formal and informal observations have been conducted through gathering firsthand data on system, processes, and behaviors within the unit of analysis. This is complementary to interviews as it covers events in their context and therefore contributes to a holistic view.

One should keep in mind that observations can be time-consuming. However, it has been necessary to investigate the processes in their natural setting. Further, the risk of the observer affecting the participant's behavior should be considered. It is important to ensure that the observation is reliable, and that the perception of the observer does not influence the data. This can be achieved by using multiple observers. (Tellis 1997) To increase reliability, two researchers have been observants in all cases.

2.4.3 Secondary data

Secondary data is information, distinction from primary data, gathered by someone else (Jacobsen 2002). The secondary data collected for this project is partly from books and articles to create a theoretical framework. Compiled documents found on Tetra Pak's intranet have also been retrieved to complement specific information about the company and its crucial processes.

Literature review

A literature review identifies and organizes existing knowledge and concepts in a subject area. This is an essential part in all research projects since the research needs to be informed by the existing knowledge concerning the phenomena. The literature review in this project has been created with the following stages: scanning, making notes, structuring the literature review, writing the literature review, and building a bibliography. (Rowley and Slack 2004)

The chosen search strategy Briefsearch was used to dive deep into the right literature, which is considered as a good starting point for further work. The strategy retrieves a few documents quickly and crudely related to the phenomena. (Rowley and Slack 2004) Initially, the case study’s phenomenon was not simple to find. The research questions are specific where no similar research can be found. Instead, literature concerning the phenomenon in similar environments was collected. After both scanning and making notes through the search strategy the following keywords were identified: supply chain management, process mapping, procurement, visibility, order handling and supply chain information systems. The keyword creates a foundation for chapter three and helps to structure the literature review.

To write the literature review, the keywords were used to retrieve even more literature. All relevant information concerning the phenomena, under each of the identified keywords, was gathered. The gathered information was then used to build a bibliography, including both identified key takeaways and literature gaps. This creates a deeper understanding of the phenomenon which is

important during the following parts of the study, corresponding to empirics and analysis. This in turn has helped to answer this case study's specific research questions.

The secondary data was gathered with three different tools described by Rowley and Slack (2004) as library catalogs, search engines and on-line databases. This project has used the library catalogs LUBsearch for locating books held by a library. The on-line database Web of Science was used as the primary search platform for articles and reports. Additionally, the search engine Google scholar has also been used. For the articles and reports, several journals have been used. The most frequently used journals are *International Journal of Operations & Production Management, Journal of business logistics* and *The international journal of logistics management* and *Supply chain management: An international Journal*.

To increase the literature's credibility, all sources have been evaluated with two checklists. The checklists are presented in Table 2-1, one for evaluating books and one for evaluating web resources.

Table 2-1: Two checklists for evaluation either books or web resources. (Rowley and Slack 2004)

Evaluate Books	**Evaluate Web Resources**
1. Relevant to the research topic 2. Written by an authoritative author, the biographical details given in the book will summarize the author's experience in the field 3. Up-to-date signaled by the publication date 4. Published by a reputable publisher in the discipline 5. One that includes extensive reference to other associated literature 6. Clearly structured and well presented, and easy to read	1. Who is the intended audience? 2. What is the frequency of updates? 3. Which organization is the publisher or website originator? 4. What is the web resource developer's claim to expertise and authority? 5. Are there links or references to other relevant web, electronic, or print sources? 6. What do reviews or evaluations of the website say? 7. Is a license or payment necessary for access to the resources?

Complementing documents from Tetra Pak

Compiled documents received from Tetra Pak´s internal function TOMS, or found on Tetra Pak's intranet, have been retrieved to complement specific information about the studied process. The specific documents that have been further analyzed are the studied process´s Standard Operating Procedure (SOP), order templates, Power Points of the organizational structure and three logbooks with order history data.

The existing SOP was vital to initially understand the major process steps included in the coordination of packaging material for internal testing. Order templates have been studied to understand how orders are performed by clients in the process today. Further, the organization's structure has been important to create an overview of all departments, and corresponding functions, that exist in the organization. This made it easier to connect involved functions to each other and

to the studied process. The three logbooks have been of immense importance to analyze several critical points. These are the number of orders going through the process, which functions and people that request packaging material, how often they request it as well as which CFs are used the most. This information has been used to make sure all clients requesting packaging material are covered in the study and to prioritize which clients and CF to focus on.

When analyzing the logbooks, potential gaps in the data should be considered. Firstly, there are three logbooks, one for each of the packaging materials, PackMat and AddMat, and one for Design Requests. The logbook for AddMat has only order information until the beginning of 2022 and Design Request until the end of 2020. Therefore, orders for AddMat and Design Request after these dates have not been included in the study. Further, there is missing order information for some orders, for example missing buying company or order date. Additionally, it is expressed that the file is updated less frequently when the workload is heavy. In some cases, this information can be assumed by looking at other similar orders. The date is easy to assume by looking at order before and after the order in the logbook, since the orders arise in ascending date. This is harder when the missing information is something else, for example buying company. To handle potential uncertainties, the results are checked by the internal functions TOMS, responsible for updating the logbooks. For completely empty rows, the order is assumed to be cancelled. In addition to this, orders without order information are excluded from the result. When analyzing the functions and people that order through TOMS, it is assumed that the cancelled and excluded orders are equally spread over all functions. Therefore, the empty rows do not have a considerable influence on the result.

All the requestors, discovered from the logbooks, have been assigned to their corresponding department at Tetra Pak by looking at the requestors' current position. There is a risk that the person has changed position since the order was made. However, this has not significantly influenced the result since the requestor with a high number of orders is contacted through an interview or by email to confirm the information. Furthermore, requestors from distinctive departments have been further investigated to decide whether the corresponding functions should be included in the study or not.

2.5 Data analysis

In this section, it is in detail described how collected data have been processed. This creates transparency needed to increase the understanding of the analyzed process that leads to results and conclusions.

2.5.1 Makigami analysis

The initial step in analyzing the information accessed through data gathering at Tetra Pak has been to structure it. To analyze the data, it is firstly structured through process mapping. More specifically, the Makigami analysis. By applying this, events occurring within the process of coordinating packaging material can be organized and structured over a period of time. Mapping

is crucial to understand the process fully and hence is a vital part in this study to answer the first research question. However, one should keep in mind and avoid the risks that can occur when producing a supply chain map. These risks could, for example, be giving away competitive information, increasing complexity through including too many details and providing an ineffective perspective for the use of the manager (Gardner and Cooper 2003).

A Makigami analysis is relevant to apply since it aims to identify losses in the current process flow, as well as giving a structured illustration of the process. The desire, when using Makigami, is to reduce waste by measuring lead times throughout the value flow. Makigami analysis can also be used to design a better future state process flow. All mentioned aspects are relevant to answering the research questions of this study.

In addition to the tool being suitable to answer the research question, it is also relevant to apply for this specific company. Today, Makigami is used by Makigami teams across Tetra Pak globally with outstanding results. Hence, the Makigami methodology is preferred to use since the case company is already familiar with the tool and has available training for employees. A well-known methodology makes the research results easier to understand and easier to implement. Makigami is also applicable when the analyzed working process is among different areas, organizations or persons. This is the case for the coordination of packaging material for internal testing at Tetra Pak, which involves several functions and people.

The Makigami tool is presented in more detail in chapter three, *Investigation framework*, under *3.4.4 Makigami analysis*. However, the method of Makigami analysis is presented in the following section.

Makigami method

The process of coordinating packaging material for internal testing at Tetra Pak was mapped to deepen the understanding of the current flow with the final aim to identify non-value adding elements. The Makigami Analysis consist of a methodology of four areas corresponding to:

1. Activities performed by different parties.
2. Documents/media used in communication.
3. Time-analysis.
4. Identified problems.

These four areas have given a holistic view of the coordination of packaging material and therefore helped answer the case study´s research questions. The Makigami methodology starts with an empty excel template. The working process is then to identify, observe and analyze actors, process steps, working documents, losses and problems and nonvalue adding activities. The most common problems are noted where the future state Makigami is mapped by removing nonvalue adding activities and redesigning the working process. The problems are handled by searching for the root causes. (Makigami Methodology 2021)

The Makigami steps are shown in detail in Figure 2-2. This case study has included the four first main steps until step 4.3, illustrated in blue color in Figure 2-2. The following steps, constituting the implementation phase, are out of scope and have not been executed. These steps are illustrated in gray color in Figure 2-2.

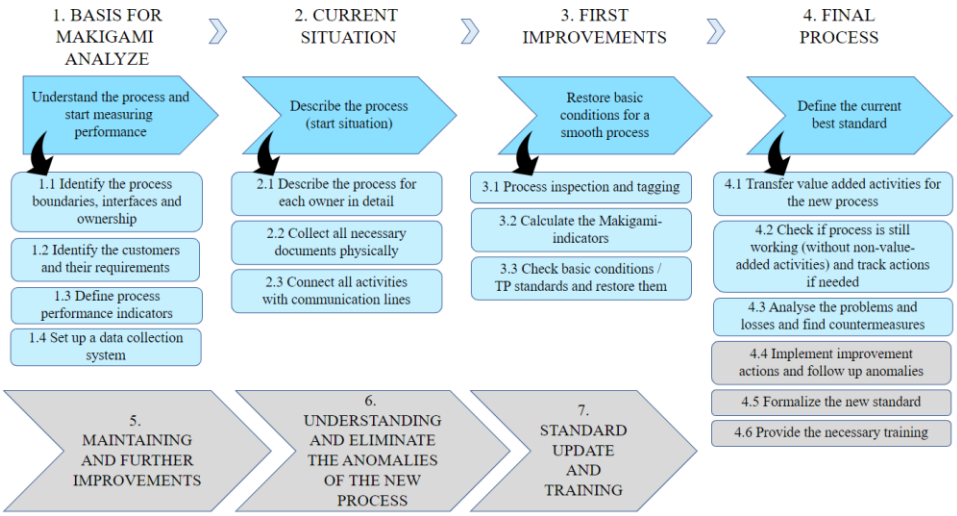

Figure 2-2: Illustration of the method for performing a Makigami Analysis. (Makigami Methodology 2021)

In step 3 *First improvements*, presented in Figure 2-2, process inspection and tagging has been completed in the Makigami analysis. For this purpose, value added activities have been defined as activities ensuring that the right material arrives on time with the client as end-customer. For example, booking a transport adds value but not the actual transport. Additionally, indicators have been calculated and these are defined in Table 2-2 below. (Makigami Methodology 2021)

Table 2-2: Definition of Makigami indicators. (Makigami Methodology 2021)

Indicator	**General definition**
Transfer	Number of transfers of information across an interface*.
Actions	Number of actions for each owner.
Documents	Number of documents at the Makigami-sheet.
Process period	Total process time, including nights and weekends.
Action time	Actual time of each activity.
Value added time (VAT)	The time of an action that adds value.
Total losses	$Actiontime - VAT$
Buffer factor	$\frac{Total\,process\,time}{Action\,time} < 30$ OK!

* An interface occurs when information is shared between individuals or information systems.

For all indicators including time, presented in Table 2-2, several assumptions were necessary. Since the process extends over a long period of time, observing the whole process through every

process step was impossible within the study's timeframe. Instead, interviews have been conducted with representatives from every function. During the interviews, questions concerning the specific function's activities and corresponding times were asked. When differences arose between different functions, the average was calculated and used in the analysis. Additionally, when parallel activities arose in the Makigami, the activity with longest process time was used.

To not get lost, it is important to keep in mind the goal and expected results during the process. The reality should be shown and at the same time make people aware of needed changes. This is true to make the working process easier. (Makigami Video Training 2021)

A best state case scenario

Due to the high number of expectations within the process, two different types of best state scenarios were created. This was achieved by first removing all activates that are not valuable, in both the current and future state Makigami process. Then the lead-time for the transport was reduced in one of the cases, since the average transport time were higher than the actual transport time for several orders through the process. This was done to show the difference in total process time between different scenarios and between the current and future state.

Information systems setup

How well business collaboration succeeds depends on the integration of business processes, the cooperation between organizations and the integration of enterprise systems. However, these processes, organizations and systems may spread over various locations and platforms. This in turn creates problems of inter-enterprise system integration due to heterogeneity of databases, platforms and programming languages. (Wang et al. 2005, pp. 305 – 306) Therefore, all information systems discovered from the process mapping have been structured and analyzed.

The noted information systems have been summarized and presented in a table, including which stakeholder in the supply chain that uses the system and why. In this way, current information systems used at Tetra Pak for the studied process have been visualized. From the table, the cooperation and integration between all information systems and functions have been evaluated. The desire was to find gaps in the current information system setup, in the upstream and downstream direction of the process. The gaps have been useful when redesigning the process of coordinating packaging material for internal testing, one process step in the Makigami analysis.

When evaluating the information system setup, it is important to think of what type of information that is shared and how often, how information sharing is supported with IT (Information Technology), implementation issues, pros and cons of different systems connected to the specific needs of the organization and number of systems needed. (Harfeldt-Berg 2022)

Order templates

The order templates have been studied to understand how orders are performed by internal clients today. To perform the analysis in a thorough way, templates have been collected from clients which are geographically spread and sent from different departments. The result obtained from the analysis have been summarized and presented in a table, including which information in the template that is required to be filled in, as well as how many cases this information is missing. In this way, potential knowledge gaps for clients in the order process were easily determined. The gaps have been useful when redesigning the process of coordinating packaging material for internal testing.

2.5.2 Analysis method

After systematically structuring the data, analysis have been performed. Pattern matching, explanation building, time-series, logic models, and cross-case synthesis are five of the most common analytic techniques used in case studies. In this project, aligned with the deductive approach, a form of pattern matching was performed through comparing patterns from the case study with patterns identified in literature. Explanation building is partly deductive and partly inductive since it bases the explanation on statements at the outset of the case as well as data from the case study. This have been suitable to apply in order to identify similarities and differences within the phenomenon, which was needed to draw conclusions. Further it strengthens the validity in the result as it aims to see if empirical patterns and predicted patterns appear to be similar. (Yin 2014)

To analyze the recommendations that have been provided and put them in the right context, the Impact and Effort Matrix was applied to be a guiding tool in giving fruitful recommendations (Kowalik 2018). Except for the factors of legal regulations and company standards that the Makigami considers, initiatives have also been evaluated based on the factors of impact and effort. How the model has been applied, and an illustration of the matrix is presented in chapter three, *Investigation framework,* under *3.2.3.2 Impact and Effort Matrix*. In addition to this matrix, the countermeasure ladder has been applied. The countermeasure ladder was added to address recurrent problems and to evaluate the recommended solutions. An illustration of the countermeasure ladder can be found in chapter three, *Investigation framework*, under *3.4.4.2 Countermeasure ladder*.

2.6 Credibility of the thesis

Regardless of whether the collected empirical data are quantitative or qualitative, it should be credible and reliable. (Stuart et al. 2002) To ensure credibility of this research, the following concepts are evaluated: validity, reliability, objectivity and ethics. Table 2-3 summarizes each aspect as well as actions taken to ensure this credibility during the research. The table includes the description of each concept and the tactics used in this case study for the corresponding concepts. The tactics are based on suggestions from theory by Yin (2014, p.45).

Table 2-3: Summary of aspects affecting credibility and tactics used to manage them.

Test	Description	Tactic used in this case study
Construct validity	The extent to which the established measurements correctly reflect the phenomena.	• Triangulation. • Multiple interviewees to get all relevant perspectives. • Structured plan for data collection and analysis procedures. • Key informants review the draft. • Observations and interviews cover events in their context which gives a holistic view. • Account for potential inaccuracies in the logbook.
Internal validity	The extent to which conjectured relationships actually exist.	• Explanation building and pattern matching. • Critical to answers in interviews by addressing rival explanations. • Same interview questions asked to several people. • Account for potential inaccuracies in the logbook. • Evaluate all literature sources through checklists
External validity	The domain to which presumed causal relationships may be generalized.	• Compare the results from the data collection with results from the literature.
Reliability	The extent to which a project's operations can be repeated and generate the same results.	• Triangulation. • A CSP. • Two interpreters and readers. • Key informants review the draft.
Objectivity	The extent to which there is freedom if bias.	• Two interpreters and readers. • Structured interviews to avoid leading questions. • Combining quantitative with qualitative data.
Ethics	The extent to which moral values or principles are considered.	• Ensure privacy, anonymity and transparency to participants

2.6.1 Validity

Validity is used in order to make sure that the project does not contain any systematic errors. The concept of validity can be divided into construct-, internal- and external validity. (Stuart et al. 2002)

Construct validity is the extent to which the established measurements correctly reflect the phenomena (Stuart et al. 2002). It is important to consider how well the chosen methods and measurements capture information about the observed phenomena in order to evaluate how suitable the methods and measurements are to answer the proposed research questions (Yin 2014). There are several ways to increase the construct validity. One way is to use the technique of triangulation, meaning looking for multiple sources of evidence when collecting data. Further, the construct validity could also be increased by describing how the data were collected and with the help of key informants reviewing the draft. (Stuart et al. 2002) For this project, construct validity has mainly been achieved by interviewing multiple persons at Tetra Pak and by using several sources for the literature review, implying the usage of multiple sources of evidence. Observations were also executed in addition to interviews, as it covers events in its context which gives a holistic view.

Internal validity is the extent to which conjectured relationships actually exist, as distinguished from spurious relationships. The internal validity of a study can be increased with the analysis methods pattern matching, explanation building and/or logic model. (Stuart et al. 2002) This study has used explanation building and pattern matching to accomplish internal validity. Also, equivalent questions were asked for each stakeholder group to increase comparability and hence increase validity. Further, potential inaccuracies in the logbooks were accounted for to minimize the risk of deficiencies affecting the validity.

External validity is the domain to which presumed causal relationships may be generalized (Stuart et al. 2002). According to Yin (2014), there is a low level of possible generalization in single case studies where the most important factor to achieve external validity is to use theory. Therefore, this project has applied relevant theory which is presented in the chapter *Frame of References.*

2.6.2 Reliability

Reliability is the extent to which a project's operations can be repeated and generate the same results. The investigated phenomenon can be affected by errors generated by the investigator or context. This can be handled by either maintaining a case study database or by using a CSP, including the procedure and how data were collected. The reliability could also, just like construct validity, be increased through triangulation. (Stuart et al. 2002) Since there is a willingness to contribute on a general level, a structured approach is required for it to be applicable to others, in addition to the case company. To ensure high reliability, this report has included a CSP, providing guidance to help ensure the study's reliability. Additionally, this project has two interpreters and readers who analyzed and discussed ambiguities and results. The collected data was gathered and analyzed in a structured way and reviewed by supervisors at LTH and Tetra Pak.

2.6.3 Objectivity

The aim of executing an objective study is to only include facts and exclude personal opinions or feelings. It should be borne in mind that all observations contain interpretation to some extent. Interpretations that are influenced by, among other things, previous knowledge and opinions. To increase the objectivity of the study, several measures are taken. Being two researchers improves the objectivity of the study, by reminding and correcting each other to exclude personal opinions. Further, when using a structured approach for interviews, the risk of asking leading questions, which could lead to observer bias, was reduced. In addition, supplementing qualitative data with quantitative data made it possible to strengthen conclusions drawn from interviews by studying the data corresponding to statements.

2.6.4 Ethics

To consider ethical factors in the study, moral values and principles were highlighted. Especially, case study research is related to ethical issues as these often require human subjects as a case of study research. (Yin 2014) To draw careful attention to this, several actions were taken. Before conducting an interview, information regarding privacy, anonymity and transparency action applied was shared with the participant. This included information on how the data will be shared and reported as well as an agreement on confidentiality, privacy and other ethical aspects. The interview guide presenting this is available in Appendix C. Thereafter, any collected data was handled according to agreements by the owner of the report. Data was only shared in the form of the finalized report considering agreements on anonymity.

3. Literature review

The following chapter presents the relevant and applicable literature for this case study. This chapter aims to create an understanding of key concepts and existing knowledge. The chapter includes relevant and applicable theories that help provide solutions and credible recommendations. Additionally, gaps in literature within the frame of reference are identified throughout the chapter.

3.1 Structure of the chapter

This chapter presents relevant literature in the areas needed to support this study. Figure 3-1 below describes the connection between the study's research questions and the chosen literature in blue.

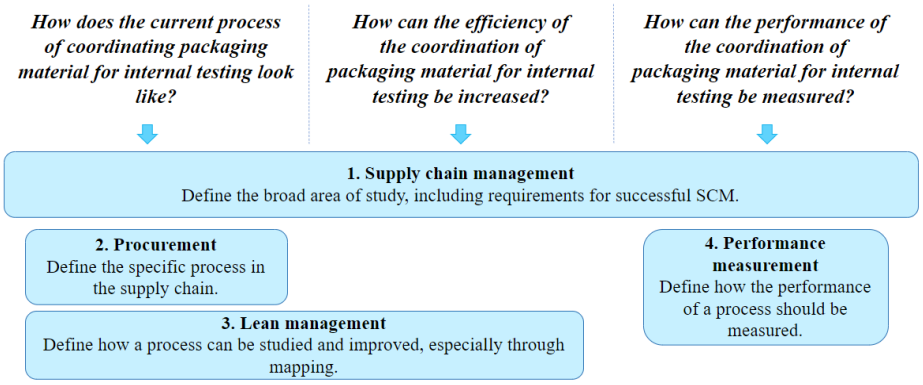

Figure 3-1: The structure of the Frame of reference. (Own illustration)

Initially, SCM as a concept is defined, why it is advantageous to work with and what requirements should be considered to succeed. The specific process in the logistics chain that this study focuses on is then defined, which is procurement. Furthermore, lean management is elaborated on to define how a process can be studied and improved, with an emphasis on mapping. Lastly, aspects of performance measurement are described to build a foundation for how to measure the performance within the area of study.

3.2 Supply chain management

Today, the concept of SCM can be considered a critical concern for any business (Lummus and Vokurka 1999; Christopher 2018; Zijm et al. 2019; Naslund and Williamson 2010). Further, the number of academic literatures dealing with the topic has increased steadily since 199 when the concept became more greatly adopted. The increase in interest can be described with several factors. One being the increased need to continuously improve the supply chain to be able to be competitive on a global market (Naslund and Williamson 2010; Min et al 2019; Du Toit and Vlok 2014). Another being able to handle and mitigate possible risks and disruptions when they occur.

The essential goal with performing effective logistics and SCM is that it can provide competitive advantage (Christopher 2018; Min et al. 2019). Not least, it is significantly important to have an effective supply chain when operating in the global market (Lambert 2008). When a business has a competitive advantage, it is in a position where it is superior to competitors in the perspective of the consumer. Competitive advantage is achieved through the organization's ability to differentiate. Additionally, it is achieved through operating at a lower cost and generating greater profit. The success of a company therefore often relies on one's ability to obtain cost advantage or value advantage, where the company optimally can combine the two in a sustainable way. (Christopher 2018)

3.2.1 Definitions of SCM

An issue with the area of study is the lack of a clear and accepted definition. There are several different definitions of the concept of SCM which have evolved as the topic has become more adopted in the recent decades (Naslund and Williamson 2010). Defining the area holds complexity due to it containing various flows, functions and components. Additionally, literature is often confined to specific elements within the supply chain and thus does not describe the concept holistically (Du Toit and Vlok 2014). Today, several definitions are used to describe the concept in literature, but often only with a slight modification. Additionally, several articles relating to SCM do not define the concept at all. (Burgess et al. 2006)

SCM builds upon the framework of logistics and aims to coordinate the processes of all entities in the flow, such as suppliers, customers and the organization itself. Logistics is a framework for planning the flow of goods and information through a business. The underlying concept of logistics is the process of managing procurement, distribution and storage of goods, as well as the related information flows. This is coordinated so profitability is maximized through cost-effective fulfillment of orders. (Christopher 2018)

Mentzer et al. (2001) presents a well-known and cited article that attempts to define SCM based on research mentioning "supply chain" up until then. Since it was published, until 2018, it has been cited over 4,925 times and had a vital role for academic research within SCM (Min et al. 2019). When summarizing the results, the definition was "*...the systemic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole*." (Mentzer et al. 2001, p.18). A definition that is still highly relevant today (Min et al. 2019).

In a report by Stock and Boyer (2009), 173 journals and books were reviewed to investigate the various definitions of SCM. When deconstructing the results, the definitions was "*The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding*

value, maximizing profitability through efficiencies, and achieving customer satisfaction." (Stock and Boyer 2009, p.706). It can be described as managing the network, consisting of upstream and downstream relationships, to achieve customer satisfaction while simultaneously generating less cost and maximizing profitability (Stock and Boyer 2009).

Even though the above-mentioned studies provide an overall picture of what the term includes, there is no unambiguous definition in the field. However, based on these comprehensive studies of the research at the time, it can be concluded that is an area that relates to principles that ensure an effective flow of goods and information, with the goal of meeting the requirements of customers and achieving competitiveness (Naslund and Williamson 2010). It is essentially the management of all activities and elements within a supply chain (Du Toit and Vlok 2014). It further includes how to collect and analyze data based on these components to make optimal decisions (Min et al. 2019). It can also be stated that there seems to be an indication over time of a move from the perspective of a chain to more of a network analogy (Naslund and Williamson 2010).

3.2.2 Requirements for successful SCM

Du Toit and Vlok (2014) describe that there are several enablers for supply chain performance. A critical enabler is information systems as effective information sharing, which is central to an efficient supply chain. Furthermore, human resource management is considered important in ensuring that the people in the organization are managed in a strategic way. Finally, infrastructure is mentioned as this is a factor that is necessary for an efficient flow of products throughout the physical chain.

Apart from the above-mentioned enablers, there are a few main areas that are often touched upon in SCM and hence should be considered when performing SCM. These are sustainability, integration and collaboration. (Naslund and Williamson 2010) Therefore, this section of the chapter aims to elaborate on these factors.

Sustainability

As industries are changing, partly because of government regulations and partly because of customer pressure, sustainability is considered crucial to stay competitive (Diabat et al. 2014). Sustainability can be defined as "*development that meets the needs of the present without compromising the ability of future generations to meet their needs.*" (Naslund and Williamson 2010). The triple bottom line is illustrated in Figure 3-2 below.

Figure 3-2: Sustainable SCM according to the triple bottom line. (Naslund and Williamson 2010)

This framework describes that sustainability is dependent on three factors and hence a balanced focus is needed on environmental performance, social performance and economic performance (Elkington 1998). The first aspect relates to not compromising the environmental resources for future generations. (Alhaddi 2015) Balancing economic performance with environmental performance is vital to perform sustainable practices (Diabat et al. 2014). Further, there is growing evidence of environmental effects due to management of resources, energy and waste. Especially for manufacturing firms, successful management of these correlates to a positive effect on sustainable performance. Therefore, these are particularly important aspects to consider. (Ali et al. 2019)

The second aspect considers the level of value to society and is specifically connected to conducting fair business. This performance indicator focusses on community involvement, fair wages and employee relations. The last aspect considers the economic value which is provided by the company to the surrounding system. The economic growth of the company should support the growth of the economy and hence the capabilities of future generations. (Alhaddi 2015)

Furthermore, since supply chains nowadays operate in an environment more prone to increasing change, there is an increased need to develop solutions that are sustainable through flexibility and adaptiveness. (Christopher 2018) For this reason, companies need to include mitigation of risks and possible disruptions in the supply chain (Neureuther 2009).

Integration

The purpose of supply chain integration is to improve process effectiveness and efficiency across all members of the supply chain. This is executed through coordinating processes in the supply chain, rather than having functional silos within the company. Further it relates to collaborative integration through maintaining long-term relationships with customers, as well as suppliers. (Naslund and Williamson 2010)

There are different types of supply chain integration. Firstly, it can be executed internally and externally at an organization. However, some claim that external integration is dependent on successful internal integration. Further, it can be the integration of the physical flow of goods between the supplier, manufacturer and end customer. Additionally, it can be integration of the flow information in the supply chain. (Naslund and Williamson 2010)

A vital part within supply chain integration is creating visibility. A major challenge for an organization can be lack of cooperation which often correlates to the creation of silos. Silos emerge when a department in an organization begins to value its own goals higher than the goals of the organization. This results in an environment where the single department's interest is prioritized over the interest of the organization. A company operating in such an environment is at greater risk of information and knowledge not being shared and of increased focus on individual goals at the expense of holistic perspective.

To work against silos the causes must be identified. Important factors which affect the build-up of silos are poor cooperation, attitude of managers, disinterest of other sections demands and organizational culture. In addition to these factors, geographical separation, financial rewards due to individual results, and lack of commitment to corporate goals also play a role. After causes have been identified, there are several activities a company can implement to remove silos. An organization's culture that encourages collaboration is an important basis for creating trust as well as information and knowledge sharing. Good cooperation should be rewarded since it signals that not only individual achievements are important. Furthermore, roles should always be clear to the individual, but understanding the roles and purposes of others should also be prioritized to create a broader understanding of each other's work. (Stone 2004)

Companies can find great benefit in improving the level of integration since cooperation is favored and the risk of conflict is minimized. Generally, supply chain integration enables better collaboration through sharing of resources, benefits and risks (Wen et al. 2007). This sharing generates a foundation for successful information exchange which can help identify issues ahead to be more responsive in a volatile market. Furthermore, integration enables the network to design high quality products faster at a lower cost. Additionally, successful integration can help reduce rework and hence project costs. (Naslund and Williamson 2010)

Collaboration

A driving force in effective SCM is collaboration (Min et al. 2005; Simatupang and Sridharan 2005; Naslund and Williamson 2010). Collaboration highly correlates to integrations as the success of each specific factor often is dependent on the other. A collaborative supply chain holds a holistic approach and a synchronized process, instead of every part of the chain individually improving. This is important since the performance of the supply chain is determined by the execution of all members involved. (Naslund and Williamson 2010) This collaboration can be done by creating common goals, sharing risks as well as rewards (Min et al. 2019). The outcomes of successful collaborations are for example, effectiveness, efficiency and improved market positions. (Min et al. 2005) Creating good cooperation is crucial in several aspects. It creates

conditions to improve customer satisfaction, increase quality, reduce costs and increase profits. In addition, it provides the opportunity to increase flexibility and control throughout the chain, better use of resources and competence.

Knowing how supply chain collaboration should be applied can be difficult. There are a number of frameworks that place great emphasis on collaboration, such as Vendor Managed Inventory (VMI) and Collaborative Planning Forecasting and Replenishment (CPFR). However, supply chain collaboration can include several things. (Naslund and Williamson 2010)

Simatupang and Sridharan (2005) present a framework for supply chain collaboration that contains the five elements of integrated supply chain processes, collaborative performance system, incentive alignment, information sharing and decision synchronization. These five features are necessary and sufficient cornerstones to help practitioners improve cooperation. Integrated supply chain processes relate to the degree to which the members of the chain succeed in designing efficient processes to deliver products to end customers in a cost-effective and fast way. A collaborative performance system refers to the implementation of the metrics used to measure the process and thereby guides the members of the chain to improve the overall performance. Incentive alignment relates to sharing risks, costs and benefits in the supply chain. Information sharing includes the level of which every partner in the chain has ability to track and trace the progress of products in every step of the supply chain. Lastly, decisions synchronization refers to how the critical decision making for optimizing profitability is executed in the chain and its members.

A structure can be created for practitioners to apply to clarify the term of collaboration. Collaboration is then described based on three levels: operational, tactical and strategic. Examples of cooperation at the operational level are the collaboration that takes place in daily activities and is hence more routine based. Tactical refers more to the activities that coordinate the flow of goods and information. It can therefore be, for example, collaboration to create visibility in the chain and thus minimize risks. The strategic level includes activities aimed at influencing the future direction of the supply chain in a collaborative manner. (Naslund and Williamson 2010)

3.2.3 Frameworks in SCM

The above-mentioned enablers and requirements should be considered when performing SCM and are often touched upon in frameworks. Within the area of SCM there are several frameworks that have been developed over the years. To exemplify what these frameworks contain and aims to succeed in, commonly adapted frameworks are shortly described in this section.

Exemplifying frameworks

The most cited framework in SCM literature is the Supply Chain Operations Reference (SCOR). The model provides a structured approach to business processes, best practices, metrics and technology. The ultimate goal is to support communication between supply chain stakeholders and improve effectiveness. (Naslund and Williamson 2010) Lambert et al. (1998) states that another commonly cited model is the Global Supply Chain Forum Framework. This tool base SCM on

eight key processes: customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development and commercialization and return management. (Cooper et al. 1997) Vital in this framework to consider is the importance of a shared understanding of processes and common definitions. Another frequently applied framework is Collaborative Planning, Forecasting and Replenishment (CPFR). This tool aims to coordinate several activities between stakeholders in the supply chain to improve performance. (Naslund and Williamson 2010)

Impact and effort matrix

When applying frameworks and thereafter determining which actions to apply to improve the supply chain, a number of factors should be considered. These could be costs, legal regulations or company standards. The impact and effort matrix is a model that is applied in the improvement phase to measure and evaluate the effort and impact of different actions. This helps determine which tasks to focus on hence it can be useful guidance in improvement work. The foundation of the matrix is illustrated in Figure 3-3 below.

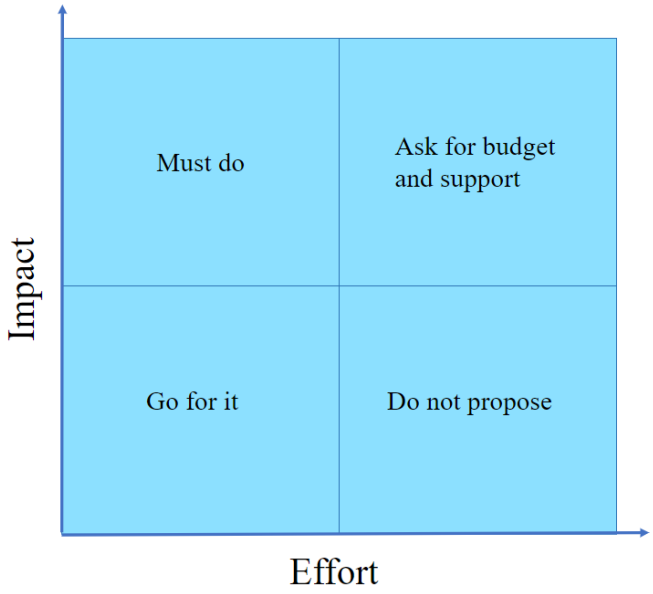

Figure 3-3: Illustration of Impact and Effort Matrix. (Kowalik 2018)

The first step is to list the initiatives. Thereafter, these are evaluated based on a scoring scale considering effort and impact individually, for example on a scale of 0-10. The matrix is then applied through plotting initiatives and evaluating them based on the level of impact and effort. Initiatives are based on the plotting sectioned into the four areas of must do, ask for budget and support, go for it and do not propose. Based on these results the initiatives can be prioritized based on the companies' specific needs or limitations. (Kowalik 2018)

3.2.4 Limitations in SCM

Despite the many benefits that can be gained from working with SCM, it is not an area without problems. One of the major shortcomings in this area is the confusion that arises because of a large number of definitions and frameworks. There is simply a lack of commonly accepted definitions and frameworks. This can lead to difficulties navigating the field, both for researchers and practitioners. (Naslund and Williamson 2010)

Although definitions created in the early stages of SCM development are still relevant and the goal of creating customer value is still central, developments have changed the image of SCM. In the past, a company's supply chain capabilities were very much made up of activities such as forecasting, planning and inventory management. Today, capabilities are increasingly about data management and seamless flows. This means that a company's ability to adapt to technological development is an even more crucial factor today. (Min et al. 2019)

Furthermore, there is relatively little empirical evidence of actual benefits arising from SCM. (Naslund and Williamson 2010; Stock et al. 2010) Frequent mentioned positive effects of managing the supply chain successfully are balanced inventory, reduced cycle times, market responsiveness, lower material acquisition costs, higher employee productivity, improved ability to meet customer demand, and lower logistics costs (Lummus and Vokurka 1999). However, the studies that do exist are often based on a chain that operates in an operational environment in specific industries. This means that it can be difficult to apply concrete frameworks for one's specific business that is not in this scope. This limitation in literature seems to correlate to the lack of a universally accepted definition.

Generally, confusion can prevent deepened understanding of the concept as a whole and the identified benefits can be difficult to gain. For researchers, there is an increased risk of missing out on the synergy effect when research goes in different directions instead of building upon previous knowledge. Hence, it can be difficult to develop applicable theory in a consistent stream. The lack of a definition can makes it more difficult for supply chain practitioners to both benchmark against other organizations or industries and claim authority in their role.

In addition to disagreements regarding the definition, there are also several, often competing, frameworks which can make it difficult for practitioners to navigate and find the most applicable theory. The lack of a commonly accepted framework results in difficulties regarding how SCM should be implemented and measured. (Naslund and Williamson 2010)

3.3 Procurement

A vital part of the logistics chain is procurement (Christopher 2018; Mena et al. 2018). It is central to the performance of the organization in areas such as quality, reliability, flexibility and sustainability (Mena et al. 2018). Mak (2014) describes procurement as a process, often documented, resulting in delivery of goods or services within a set timeframe.

The most representative procurement process model is a four-phase model consisting of the following phases: information, negotiation, settlement and after-sales. However, there are several variants of the procurement process model containing both more and less detailed phases. One example of a more detailed model includes the following phases: search and select supplier, develop input specifications, negotiate terms, order input, monitor quality and fix problems after the order. Regardless of the number of phases in the procurement process model, the preformed activities in each phase need to be coordinated. The coordination between a selling and buying organization could be either bilateral or multilateral. Bilateral coordination corresponds to direct coordination, one-to-one or end-to-end. Multilateral coordination, many-to-many, corresponds to contact using intermediaries, for example e-marketplaces. (Kim and Shunk 2003)

An organization's procurement function is typically subdivided into operational- and strategic processes. This is due to the priorities and activities within these areas being completely different. Strategic procurement is typically assigned with tasks corresponding to supplier management, procurement-oriented product development and pooling of Purchase Requisitions (PR). On the other hand, operational procurement concerns administrative routine work such as converting purchase requests into purchase orders, individual transactions and ensuring the correct allocation of invoice received. (Puschmann and Alt 2005)

3.3.1 Procurement vs. purchasing

To answer the research questions, which relate to the total process that results in delivery of goods, procurement is the most applicable area. Procurement involves activities such as identification of needs, sourcing, selection, negotiation, ordering, order handling, receiving and payments. It includes steps applied to ensure that goods and services can be acquired. The procurement process varies between companies since it is dependent on its specific needs. Further, purchasing includes functions involved in acquiring goods and services, such as obtaining PR, ordering, receiving and payment. Both procurement and purchasing are involved in the process of acquiring goods and services, hence they are both relevant. (Mak 2014) Procurement, in contrast to purchasing, involves all steps that occur before, during and after a purchase, an active process of achieving the outcome (Mak 2014; Pereira et al. 2014).

The difference between the two concepts and how they are connected is illustrated in Figure 3-4. The figure is based on van Weele´s (2014) purchasing process model with related concepts.

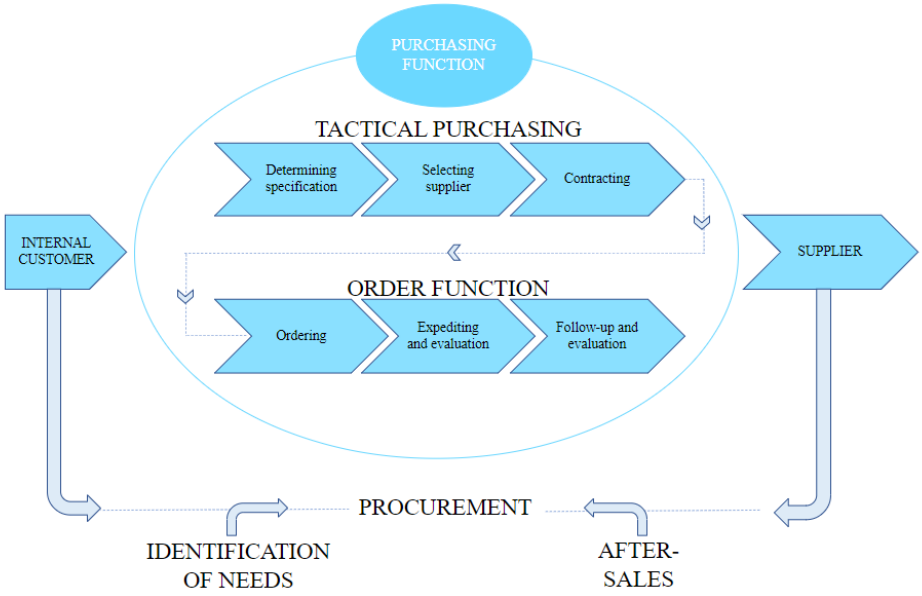

Figure 3-4: Illustration of purchasing and procurement. (van Weele 2014)

Internal vs. external suppliers

Today, basically all organizations struggle with the make-or-buy decision, concerning who should be doing what in a manufacturing supply chain. The decision concerns whether to outsource or insource an activity. Outsourcing is typically defined as letting an external organization perform work that formerly was done inside the organization, while insourcing corresponds to work that is performed by the organization internally. It is beneficial for a firm to keep core competences in-house, focusing on critical components that the company is distinctively good at, and outsource, or subject, other activities.

Out- and insourcing can be considered as the choice between external and internal suppliers. Internal suppliers are those suppliers that have a supplying function in a manufacturing network and belong to the same organization as the plants that finalize the goods. External suppliers are all other suppliers outside the organization, external to the ownership of the focal firm.

The main selection criteria for the choice between internal and external are quality, delivery, cost and flexibility, the basic competitive priorities for manufacturing firms. However, an internal supplier is largely chosen based on a single corporate decision, while external suppliers need to perform on several criteria such as primary quality, cost and delivery dependability. Hence, a significantly higher emphasis on cost for external suppliers. Additionally, the selection criteria for external suppliers are better aligned with plant performance and market goals compared to the selection criteria for internal suppliers. (Feldmann and Olhager 2008)

3.3.2 Direct vs. indirect procurement

The procurement concept can be broadly divided into direct procurement and indirect procurement (Kim and Shunk 2003; Puschmann and Alt 2005). Direct procurement is the procurement of direct goods, meaning materials used in the production phase of the supply chain. Indirect procurement is the procurement of indirect goods, material not used in the manufacturing of goods. Examples of indirect goods are office supplies and equipment, software and other IT equipment, marketing kits and services, capital goods, travel reservations, MRO (Maintenance, Repair and Operation) and computers. Accordingly, indirect goods are supplies used by a company in day-to-day operations.

Traditionally, the procurement function has focused on direct procurement, especially streamlining the inflow of direct goods and increasing the structured procurement processes efficiency. The procurement of direct goods can meet demand by being schedular in a timely manner and with sufficient information regarding the demand and material source available. In parallel to the routine buying procedures, IT has been utilized with, for example, automated replenishment systems. On the other hand, indirect procurement has received less attention. The procurement of indirect goods has historically been managed manually, with little process standardization, through a lot of paper-based activities and via phone or mail. Therefore, IT has not been utilized to the same extent as for direct goods. The major opportunities for time and cost savings in this area have resulted in numerous reengineering and e-procurement projects. (Kim and Shunk 2003)

3.3.3 E-procurement

New technology through e-business has the potential to generate wealth and promise substantial benefits. Connected to the procurement function, the benefits of e-business can be accomplished through e-procurement. (Knudsen 2003) E-procurement is defined by Kim and Shunk (2003) as *"an organization´s procurement using the Internet technologies".* Further, e-procurement can yield significant efficiencies, time and cost savings by supporting and automating the procurement process. All levels across an enterprise can be positively affected, for example, through self-service transactions. (Kim and Shunk 2003)

E-procurement aims at realizing more efficient and faster operational procurement processes. Consequently, the purchasing department can be bypassed, which enables more time for strategic tasks. Thereby, e-procurement tools create the possibility for the requester to directly search and select products in an electronic catalog, where the catalog is negotiated in advance by strategic procurement. (Puschmann and Alt 2005) There are several applications and tools within e-procurement. However, the e-procurement tools need to operate in conjunction with the corporation in order to make sure the procurement strategies are consistent with the competitive strategy. (Knudsen 2003)

Knudsen (2003) describes seven forms of e-procurement applications corresponding to: e-sourcing, e-informing, e-collaboration, e-tendering, e-reverse auctions, Web-based Enterprise

Resource Planning (ERP) and e-MRO. Each application's functionality and location in the procurement process are presented in Table 3-1 below.

Table 3-1: E-procurement applications. (Knudsen 2003)

E-procurement application	Functionality		Location in the procurement process
E-sourcing	The process of finding new potential suppliers using the Internet through a Business to Business (B2B) marketplace.		Information gathering.
E-information	Handles information about the supplier, including quality certifications, unique capabilities or financial status from own investigations or provided from a third party.		Information gathering.
E-collaboration	Reduce errors by making it possible for the supplier to sync with the buyer. This is done by visualizing information of correct and updated data, available from the buyers Website or extranet. Can also encompasses the usage of different collaboration tools.		Gathering and disseminating of purchasing related information.
E-tendering	The process of sending, for example, Request For Information (RFI) or Request For Price (RFP) to suppliers, includes receiving the responses, using IT. Can also include an initial screening process of a few selected suppliers.		Suppliers contact step.
E-reverse auctions	Enable for lowest price and other conditions of goods and services through IT, often traded in real time. The process ends in a closing bid between supplier and buyer.		Negotiation step.
Web-based ERP	Connected to the processes of placing the orders, creating and approving purchasing requisitions and receiving the ordered goods or services. This is done using IT, through a software system.	Handles product-related items.	Fulfilment step.
E-MRO		Handles indirect items, including maintenance, operating and repair materials.	

E-procurement applications can increase the integration between organizations and between internal functions (Knudsen 2003). Cross functional integration is crucial to increase the visibility connected to procurement, both internally and externally. Internally, procurement managers can provide supply managers with information about, for example, pricing, discounts, supplier capacity and new product information, allowing them to make more reliable decisions. Externally, the procurement function is responsible for product quality, supplier selection, cost of goods or services, delivery timeframes and supplier relationship. The relationship between supplier and buyer requires information sharing and collaboration between managers from both sides. Four types of buyer-supplier relationships are as follows: basic, cooperative, interdependent and integrated. (Pereira et al. 2014)

Every organization has its own business process, meaning all e-procurement systems are not equally suitable for supporting all businesses distinct process. Just as a single information system cannot meet all the business requirements and companies need to implement e-procurement systems and business models in a seamless and hybrid manner. (Kim and Shunk 2003; Puschmann and Alt 2005) However, procurement with transactions that involves a large amount of communication and processing of information is well suited for IT automation and support throughout all transaction steps. (Kim and Shunk 2003) Worth mentioning, the potential value of e-procurement is harmed by a low level of support and system provision for the end-users expected to use the applications in daily routines. Providing support for all new users is a key challenge when implementing new e-procurement tools, especially when the internal users may be spread globally at different sites. Additionally, the support needs a high level of compliance in order to maximize the new applications benefits. (Brandon-Jones 2017)

3.3.4 Procurement performance

The procurement function plays a fundamental role in an organization and can increase competitiveness, influencing an organization's profitability in a positive way (Pereira et al. 2014). Knudsen (2003) agree with this statement and explains that *"the procurement function can contribute to the success of the corporation"*, since a firm market position can be enhanced by developing a procurement strategy with focus on the strategy´s competitive strengths.

To enhance the procurement function´s performance, implementing appropriate measurements of procurement performance is a requirement. The procurement function is influenced by the interactions between various elements, staffing levels and budget resources, professionalism, organizational structure, regulations, guidance, rules and internal control policies.

The performance of procurement is suggested to start from purchasing efficiency and effectiveness in the procurement function. Purchasing effectiveness and purchasing efficiency represent different capabilities and competencies. Effectiveness reflects that the organization is doing the right thing, while efficiency reflects that the organization is doing things right. There is a challenge to balance these two parameters since an organization can be effective, but fail to be efficient. (Kakwezi and Nyeko 2019)

Historically, organizations have concentrated solely on cost and saving indicators to measure performance (Kakwezi and Nyeko 2019; Pereira et al. 2014). The purchasing function was praised when costs decline and in turn queried when savings decline. However, the performance measures can be both financial and non-financial. When solely using financial measures, market dynamics, quality of procured goods or services, customer satisfaction, flexibility, timely delivery of orders and quality of employees are ignored. Therefore, all core areas and activities of procurement should be included. (Kakwezi and Nyeko 2019)

In the context of e-procurement, the internal service providers deliver e-procurement. Internal customers refer to individuals who place orders, receipts, authorize and receive support from an internal service provider. However, there is a lack of literature that attempts to measure the

performance of internal service quality. Instead, traditional Business-To-Customer (B2C) service quality measures have been adopted as a popular approach. This can cause problems, since the internal and external customers consume differently, choose service providers differently and have different levels of experience. It is important to include confidentiality, support flexibility, training, attention to detail, leadership, information relevance, proactive decision making and communication when applying the B2C service measures to internal service contexts. Especially, training, professionalism, content, usability and processing are important for evaluating e-procurement quality for internal customers. (Brandon-Jones 2017)

3.4 Lean management

For the last 30 years, the lean production movement has, with basis in the Toyota Production System (TPS), dominated manufacturing trends. TPS is Toyota's unique approach to manufacturing and the framework for what is often called "lean" management. The goal with TPS is to produce a continual flow of value to the customer. A continual flow, or free flow, is a flow without interruptions known as waste. This requires a system of both people, equipment, and processes, all operating at peak performance. The people closest to the "gemba", meaning closest to where the work is performed, must address variability through continuous improvement. Continuous improvement is the driver for building a sustainable enterprise since the world is constantly changing. Only developed people at the gemba with motivation to improve and solve problems can understand the problems and react quickly enough. (Liker 2020)

3.4.1 The background of TPS

TPS arose during the 1940s, when the fledgling auto company faced real problems during their manufacturing of cars and trucks. The company had no other choice but to eliminate waste. The TPS can be represented by a house with two pillars of just-in-time and jidoka resting on a foundation of operational stability. In the center is the culture with people that continuously improving, see Figure 3-5. (Liker 2020)

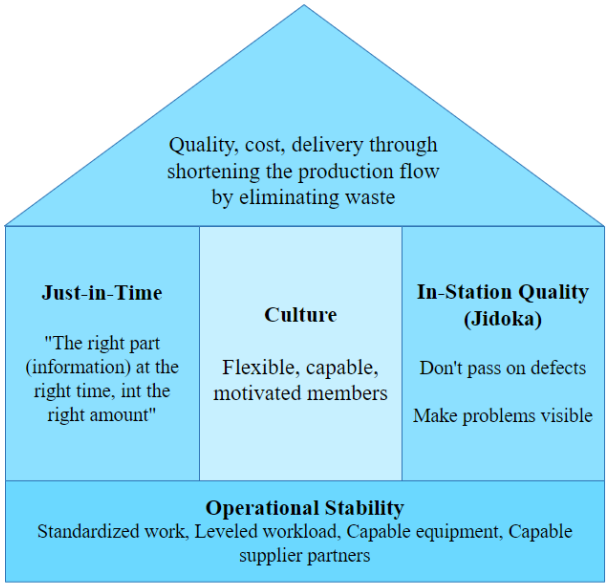

Figure 3-5: Illustration of the concept TPS. (Liker 2020)

Lean management has been embraced in several sectors from healthcare to construction. The philosophy consists of a system with interconnected people and processes, working to deliver value to customers by continuously improving how they work. Lean production is not entirely new since it is built on the strengths of both craft- and mass production. By avoiding the high costs of craft production and the rigidity of mass production, lean production is keeping less inventory on site, has fewer defects and produces an ever-growing variety of products. Compared to mass production, lean production also uses less of everything, for example, half the human effort in the factory, half the investment in tools and half the manufacturing space.

Without lots of inventory, time or information buffers, lean production has no safety net. However, problems will appear quicker and therefore be solved quicker, making the foundation of stability even stronger. Less inventory allows for a better flow where problems effectively can be controlled as they occur. (Liker 2020)

3.4.2 Fourteen principles

A common Toyota refrain is “Use all your senses” to fully understand the work task and process in order to improve it. As a guideline, 14 principles have been compiled around four Ps: philosophy, process, people and problem solving. Scientific thinking has also a significant role since continuous improvement depends on people that detect and correct problems, in other words thinking scientifically. The principles are summarized under the four Ps, found in Figure 3-6, where scientific thinking is placed in the middle. (Liker 2020)

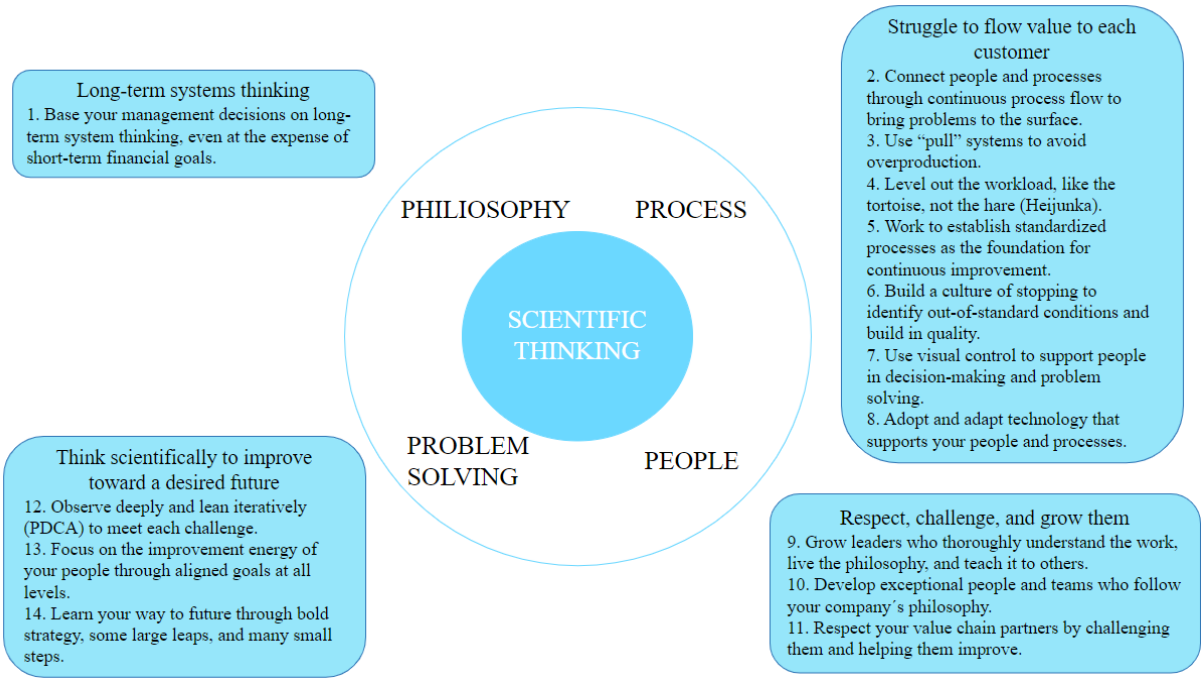

Figure 3-6: Scientific thinking and the Toyota Way as a system. (Liker 2020)

It is important to understand that lean is not a tool kit that could be used to remove waste from processes, ready to be installed as a hardware or software upgrade. There is not one solution that fits all. Every company need a unique strategy where the principles can work as ideas or inspiration to pursuit one specific company´s vision of excellence. (Liker 2020)

3.4.3 Waste

The ideal flow is a one-piece flow that is pure value added from the start until the delivery to the customer. All blockages, interruptions and rework in the flow are diverse types of non-value adding waste in the process. (Liker 2020; Kadarova and Demecko 2016) Seven major types of waste are summarized in Table 3-2 below.

Table 3-2: Diverse types of waste. (Liker 2020)

Waste	Description
Overproduction	Waste as overstaffing, unnecessary storage and increased transportation costs generated by excess inventory costs that arise when producing ahead of or in anticipation of demand.
Waiting	Waiting or watching a machine or waiting for key inputs (time on hand).
Unnecessary transport or conveyance	Inefficient transport of material in or out of storage or between processes which arise when the work in process is carried out over long distances.
Overprocessing or incorrect processing	Unneeded processing steps that could arise from example poor tools that causing unnecessary motions and defects. Higher-quality products or services can also generate waste if the higher-quality is not necessary.
Excess inventory	Longer lead times, damaged goods, obsolescence, storage and transportation costs and delay caused by excess raw material, work in process or finished goods. Extra inventory does also hide problems like late delivery from suppliers, equipment downtime, production imbalances, defects, and long setup times.
Unnecessary movement	Wasted motion performed by employees during their work. Through searching, reaching, looking, or stacking for various parts and tools.
Defects	The production of defects and consequently repairs, rework, scrapping, replacement and inspection time, effort, and handling.

Lean includes several methods and tools used for improvement work. Each approach is designed for a specific type of problem to visualize and remove sources of waste. The improvements are accomplished through redesigning the process. Examples of methods and tools emphasized in lean are the following: kanban and pull, single-piece flow, 5S, demand levelling, kaizen events, visual management, A3 reports and value stream mapping. (Kadarova and Demecko 2016)

3.4.4 Makigami analysis

Makigami analysis is an application of lean philosophy through a Total Preventative Maintenance (TPM) tool applied to study the process and identify the non-value adding elements. When the current process is mapped, the Makigami analysis does also include designing a better future state process flow. (Chakraborty et al. 2016) Furthermore, the tool encourages the creation of a standard workflow for the analyzed process (Tonkin 1997).

The first Makigami was made 1996 by Okamuran-san at Fuji (Makigami Methodology 2021). The tool can be accomplished with paper and pencil. Makigami means roll of paper in Japanese. Further, Makigami is a process mapping tool used to communicate, visualize and analyze a business process. Especially, the movement of information, people and products, between various process steps, are visualized. It is important to identify all the functions involved, what triggers downstream steps to work, whether additional resources are needed, whether there exist standard work steps and how waste can be attacked, in order to create an improved future process. (Tonkin 1997)

Advantages with Makigami

There are several benefits to take advantage of by using Makigami as a structural process mapping technique. In relation to other mapping tools, one major advantage is that Makigami increases the visibility of a working process and thereby can tackle non-visible flows and identify interfaces easily. Furthermore, the working process is mapped in detail, including all team members, and highlights losses that occur in the flow of an activity in a structured way. A loss corresponds to the use of a resource without adding any additional value to the final customer's product. A loss can for the most part be eliminated but is often perceived as inevitable. Losses can for example correspond to overproduction, waiting time, defects, inventories, no added value processes, excessive movements or excessive transport time to mention a few. The different areas of losses that *should* be identified are presented in Table 3-3. One conclusion is that the process without any losses is the cheapest. (Makigami Methodology 2021)

Table 3-3: Looses. (Makigami Methodology 2021)

Losses	Type	Cause
Management Loss	Unplanned	Not ordered to work.
	Direction waiting	Waiting to order by boss or any other department.
	No-information	Not enough information to proceed.
Process Loss	Unnecessary work	Perform low priority or no important work.
	Sectionalism	Unbalanced work volume.
	Duplicated work	Same work item done by several departments.
	Post	Write information on another document.
Speed Loss	Delay on deadline	Delay to the appointed date of delivery.
	Reduced work speed	Low efficiency work caused by stop.
	Long lead-time	Setting lead-time too long.
Distribution Loss	Travelling	Distribute documents by foot.
	Layout	Long distance work process caused by unsuitable layout.
Motion Loss	Not standardizing	Different ways for work process.
	Finding	Extra time to look for necessary documents.
	Manual work	Manual work to enable computer processing.
	Duplication check	Extra process for checking information.
Skill Loss	Unskilled	Extra time caused by untrained personnel.
	Multiple skill	Not able to work without a specific person (specialist).
	Unsupported	Lack of knowledge/skill of the needs to provide support.
Decision Loss	Decision delay	Extra time to decide.
	Meeting time	Do not start or end meetings on time.
	Miscommunication	Not enough/incorrect communication to understand each other.
	Many processes	Extra processes for decision-making.
Defect Loss	Miss operation	Extra time caused by operation error.
	Operation inaccuracy	Incorrect operation.
	Rework	Redo the work to correct or complete it.

The Makigami tool is powerful since it is easy to understand and has tremendous benefits that are simple but rigorous. The desire, when using Makigami, is to reduce waste by measuring lead times throughout the value flow. Common improvements with the tool are faster throughput time, less output errors, less transfer, reduced costs, reduced lead-times, decrease in non-VAT, or increase in job quality. (Makigami Methodology 2021)

Countermeasure ladder

In addition to the Makigami analysis, the countermeasure ladder can be applied. The countermeasure ladder is a tool developed within lean management. It requires discipline but when applied well, the tool is extremely effective with results in significant increase in countermeasure

permanency and long-term gains. The tool is illustrated in Figure 3-7 below. For each root cause, start in the top of the ladder (Level 6) to define a countermeasure. In this way, the normal way of working is challenge with the aim to eliminate the operation. To prevent recurrent problem, the best possible countermeasure is used, the higher in the ladder the better. The tool has specifically been used in safety and health to reduce the risks caused by unsafe working methods or human unsafe behaviors. (Makigami Methodology 2021)

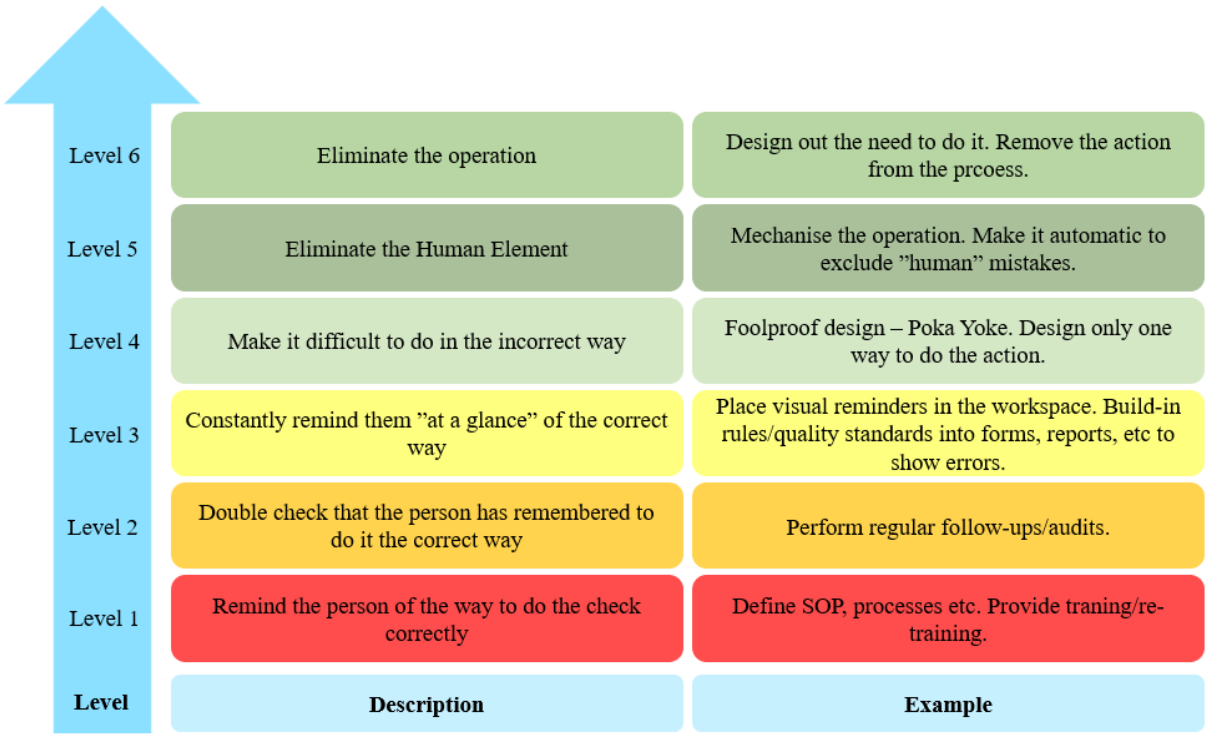

Figure 3-7: Countermeasure ladder. (Makigami Methodology 2021)

Logistic process redesign

One step in the Makigami analysis is to improve the current process flow by redesigning it. Persson (1995) suggests some useful insights when redesigning a logistic process with nine strategies. The strategies are presented in Table 3-4 with corresponding tactics.

Table 3-4: Useful strategies when redesigning a logistic process. (Persson 1995)

Strategy	Tactics
Reduce or redistribute lead times	Reduce lead time at the expense of another cycle by finding new ways to do the work tasks, in a new and less time-consuming manner: • Carry out individual activities in sequences, parallel to each other. • Reduce waiting time by synchronizing activities. • Reduce the time for carrying out individual tasks by simplifying them.
Reduce or adapt to uncertainties	Different types of techniques and methods can be used to reduce different types of uncertainties: • Forecasting or cycle counting. • Supplier development and cooperation. • Co-planning involving major customers. • Planning and control techniques.
Redistribute or increase frequencies	Manage by: • Reduce set-up, changeover times and geographical proximity. • Redistributing frequencies.
Eliminate or adopt to expected pattern of demand	Change the demand patterns by: • Change prices. • Close cooperation with major customers. • Control orders between warehouses.
Simplify structures, systems and processes	Reduction of decision elements by: • Standardization or reduce number of levels. • Modular-built products and components. • Elimination of slow-movers and obsolete material. • Reduction or reorganization of the supplier base. • Value analysis.
Differentiate	Measures that find new and more effective ways to categorize and group products, system and processes: • Different categories, set of principles, methods and procedures.
Postpone	Carry out an activity as late or as close to the actual need in time as possible: • Geographical: wait to move the material until it is necessary. • Adding value: wait with final assembly, labeling or packaging.
Improve the information processing and the decision support system	Manage by: • Simplification of the transaction. • Substitution. • System consistency.
Strengthen the internal and external integration	Manage by: • Coordination: informal, formal or organizational.

Mapping

Since Makigami is a mapping tool, some background about mapping will be presented in this section. With outsourcing strategies, supply and delivery systems are becoming increasingly global. This in turn makes the visualizing, tracking, and managing of the supply chain more complicated. A map is a great tool to visualize the supply chain and works as a link to the strategic planning process. Further, the map can be used to evaluate the supply chain membership and the supply chain structure.

A map is a simplified model that corresponds to a spatial representation of the environment. Therefore, the map is a stand-in for the actual environment but needs to capture the essence. The map is created of graphic constructions, corresponding to a form of visual language that communicates items of information. In this sense, a map is a powerful tool that can be used to see a large and complex reality. A good map should be interpretable, should have an easy-to-disseminate format and be recognizable. It is also beneficial to use standardized icons and conventions, such as color-coding or symbol-coding, for various kinds of functions. However, there is not yet a universal convention that should be used for mapping a supply chain. (Gardner and Cooper, 2003)

To distinguish process mapping from strategic supply chain mapping three characteristics corresponding to orientation, level of detail and purpose, could be evaluated. The orientation corresponds to the focus of the mapping procedure. When using supply chain mapping, the focus is on the flows of goods, information, and money through a firm, in both upstream and downstream directions. Processes may be included but unlike process mapping, which instead focusses on the operations or systems within a company. The existing system is evaluated by flowcharts and efficiency measurements to develop an improved process design. The level of detail is therefore high for process mapping since the process is broken down into several activities and steps. For supply chain mapping an overall perspective is shown, including how processes work together between companies. The non-critical entities are therefore excluded to keep the map simple.

The purpose of supply chain mapping is to ensure that the current supply chain is aligned with the already existing strategy. The map could also be created in conjunction with the creation of a supply chain strategy. Process mapping is typically tactical rather than strategic. The map is usually isolated to one function or process at a time to improve operating efficiency. This can be done through changes in the current operations by recognition of a problem area. The differences between the two mapping techniques are summarized in Table 3-5. (Gardner and Cooper, 2003)

Table 3-5: Differences between Supply chain mapping and Process mapping. (Gardner and Cooper, 2003)

	Supply chain mapping	**Process mapping**
Orientation	External	Internal (typically)
Level of detail	Low to moderate	High
Purpose	Strategic	Tactical

3.5 Performance measurement

Performance measurement focuses on maximizing benefits and minimizing negatives by supporting a company in assessing performance to determine if company expectations are met. Generally, measures are monitored over time and aim to give an indication of the rate of improvement. (Hatry 2006) Further, Neely et al. (1995) describes performance measurement as a process of determining the efficiency and effectiveness of actions, where the metric is the factor which quantifies it. However, a consistent definition of a performance measurement system has not been agreed on by researchers (Franco-Santos et al. 2007).

3.5.1 Benefits of performance measurement

As the business environment is constantly changing and global competition is increasing, the need for value creation and maintaining competitiveness is important. In a dynamic and resilient business environment, the implementation of appropriate performance measurements is seen as a significant factor. (Yadav and Sagar 2013) However, notably is that there is little emphasis on performance measurement in literature linked to increasing efficiencies in supply chains (Naslund and Williamson 2010).

Vital in performance measurement is to identify success and evaluate if customer requirements are met. (Neely 1999) Assessing performance successfully can help a business improve operations, as well as increase responsiveness. (Nudurupati et al. 2011) Further, performance measurement ensures that decision-making is based on facts, rather than emotion or intuition. Evaluating employee performance enables companies to provide helpful feedback and communicate expectations to team members. This generates a foundation for creating motivation since incentives are made clear. Furthermore, it allows for the organization to better understand processes since it can help visualize where improvement is necessary, for example where issues such as bottlenecks and waste arise. Additionally, it can provide data on where performance is satisfactory and hence help the organization to focus on the right areas. (Neely 1999)

To succeed in a highly competitive and global market, being responsive to changing customer needs is crucial. To be responsive and act proactive when challenges occur, accurate and real-time information about the business' is important. When using a system to measure success over time, you are more likely to be able to provide accurate and real time data. It should be noted that this information is required to be accessible and visible to enable fast decision-making. (Nudurupati et al. 2011)

3.5.2 How to measure performance

To fully reap the benefits of measuring one's performance the metrics should be carefully considered. Not measuring the right areas and measuring inaccurately, results in data that is misleading, non-reliable and increases the risk of bad decision making. (Hatry 2006) Generally, a guideline for setting targets is the SMART model. This model concludes that a target optimally should be specific, measurable, achievable, relevant and time specific. (Bjerke and Renger 2017)

It is common for organizations to measure performance through a few predetermined goals, based on a few specific units within the organization. For example, a specific department or individual. This method thus indirectly assumes that the overall strategic goals in the company are achieved when the different unit's goals are achieved. However, this method is flawed as a certain unit's performance does not demonstrate how key processes perform. This increases the risk that companies will find it more difficult to improve processes and make advantageous decisions. Thus, one should avoid measurement that is only internally focused. The focus should instead lie on the overall performance, including all relevant units and aim to develop process-based measurement systems. (Naslund and Williamson 2010)

A fundamental of performance measurement is that measures should be aligned with the strategy of the organization. Therefore, measurement should be reviewed regularly to ensure that the alignment is constant, and that the focus lies on what is important. In addition, it is important that there is support from senior managers to measure this success, where the key is to ensure that it is an activity that is helpful for the organization. It is also important that there is equal support from the employees, as they should understand why they are needed and how they can support them in their work and the process of improving. Further, the measurement should be applied to all parts of the organization. If not, it may seem that not all parts are of equal importance and there may be reason to question why that part of the organization is even needed. Lastly, the correct performance measurement framework is only valuable if it can be ensured that data will be analyzed and translated into action. Therefore, it is of great importance that the link between measurement and behavioral changes is clear. (Neely 1999)

Zeglat et al. (2012) describes that the measures and systems used to measure performance are several and continuously evolves over time. However, common features in performance measurement systems are supporting infrastructure and performance measures (Franco-Santos et al. 2007). Generally, the creation of a balanced performance measurement framework is crucial to reap the benefits of the tool. A traditional area to measure has been financial aspects, such as cash flow and profit margins. These can be advantageous since they are precise and objective. However, they fail to include less tangible factors such as quality and customer satisfaction. Further, they visualize only historical data and are due to that often not useful in predicting the future state. Therefore, there is a need to integrate non-financial aspects as well. Quality, operational and strategic perspectives can be used to complement a financial perspective. (Yadav and Sagar 2013)

The balanced scorecard

To present an exemplifying framework, The Balanced Scorecard (BSC) will be described. The framework presented by Kaplan and Norton (1992) is the most cited in literature. Therefore, it has been highly influential in the development of the concept (Berg et al. 2015). In general, BSC describes that there should be a balance between several different perspectives. For example, a balanced measurement is not achieved by taking only financial performance into account. The perspective one should consider are customer, internal, learning and growth and financial perspective. These perspectives are further elaborated in Table 3-6 below.

Table 3-6: The perspectives and correlated questions to answer in a BSC. (Kaplan and Norton 1992)

Perspective	Provide answer to
Customer	How should we appear to customers to achieve our vision?
Internal	What business processes must we improve to satisfy shareholders and customers?
Learning and growth	How should we sustain the business ability to change and improve to achieve our vision?
Financial	How should we appear to our stakeholders to financially succeed?

Additional important factors to consider are to investigate it from a process perspective and to base the measurement on the company's vision and overall strategy. Therefore, the suitable area to measure is unique to each company's specific strategy. (Kaplan and Norton 1992) Further, once setting an appropriate BSC it should be ensured that it is sustainable in the long term. The BSC and its selected metrics might need to be adjusted as the organization and its culture and goals change over time. Notably is also that the people of the organization are key for the BSC to be effective since it needs to be commonly accepted at all levels of the organization. (Chavan 2009)

Supply chain operations reference

Another exemplifying framework is a measurement system based on SCOR. SCOR is a strategic planning tool developed by the Supply Chain Council. The purpose is to decrease the complexity of SCM by simplifying it and assisting in decision making. (Huan et al. 2004) It builds upon the four areas of processes, performance, people and practices. The performance section of SCOR focuses on the execution of supply chain processes. (ASCM 2023) This system is also useful since it provides a standardized way of looking at a supply chain. (Holmberg, 2000) Three different performance categories, and eight performance attributes are included in this framework. These are further developed in Table 3-7 below.

Table 3-7: The performance attribute and correlating definitions in the SCOR model. (ASCM 2023)

Performance categories	Performance attributes	Key Performance Indicator (KPI)
Resilience	Reliability = The ability to perform a specific task as expected and the predictability of the fallout of a process.	Perfect order fulfillment, perfect supplier order and perfect return order fulfilment.
	Responsiveness = The pace of the supply chain tasks bringing products to the customer.	Order fulfillment cycle time.
	Agility = The ability to adapt to external conditions to gain or sustain a competitive advantage.	Supply chain agility.
Economic	Cost = The cost of operating the processes in the supply chain.	Total SCM cost, cost of goods sold.
	Profit = The financial margin when revenue arising from a business activity outpaces the expenses, costs, and taxes involved in sustaining the activity.	Earnings before interest and taxes as a percent of revenue, effective tax rate.
	Assets = The ability to efficiently use capital.	Cash-to-cash cycle time, return on fixed assets, return on working capital.
Sustainability	Environmental = The ability to perform Supply Chain Operations (SCO) with minimal environmental impact.	Materials used, energy consumed, water consumed, GHG emissions, waste generated.
	Social = The ability to align SCO organizational values.	Diversity and inclusion, wage level, training.

3.6 Investigation framework

The frame of reference has been presented based on the four main sections of supply chain management, performance measurement, procurement and lean management. Describing these areas builds a framework of the knowledge required to answer the research questions of this study. Each of the sections key takeaways are summarized below.

Supply chain management provides a basis for creating an understanding of the concept as a whole and creates a foundation for what is relevant to focus on during data analysis to map the current process. This section also clarifies which aspects should be considered to offer a sustainable solution. This gives the authors guidance in how to give fruitful recommendations for the case company. Finally, shortcomings in current research are addressed. Shortcomings are important to keep in mind when working in the field as the report wishes to contribute to counteracting these shortcomings.

Procurement is described as a vital part of the supply chain that involves all steps occurring before, during and after a purchase. Clarifying the specific area in the supply chain creates greater

understanding of the selected phenomenon. The concept is described including different types of procurement and how several applications and tools can be utilized for greater performance. These applications and tools can then be used to answer research questions regarding how the procurement process can be improved. Lastly, measurements for procurement performance are discussed which contributes to the last research question regarding measuring performance. When executing the literature review it has been noted that literature has an emphasis on external procurement, and less information about internal. Additionally, this is also the case for performance measurements of procurement with less research connected to internal procurement. Hence, shortcomings in the current research are addressed as the report wishes to contribute to counteracting these shortcomings.

Lean management has been embraced in several sectors with the goal of creating a continual flow of value to the customers, without waste. 14 principles are highlighted followed by a description of diverse types of waste. Makigami analysis, an application of lean, is presented including the tools advantages. Since Makigami is a process mapping application, the concept of mapping is discussed, which provides guidance for the researchers when applying the tool.

Performance measurement introduces the area and what benefits can be obtained from applying a framework for measuring the performance. Factors that need to be considered when developing a framework are described. To exemplify what this may contain, two well-known frameworks suitable for SCM are presented. This information enables for the authors to give recommendations on how performance measurement should be applied to answer the last research question.

Figure 3-8 below describes the connection between the study's research questions, the presented literature in light blue and the coming results in the bottom of the figure in darker blue.

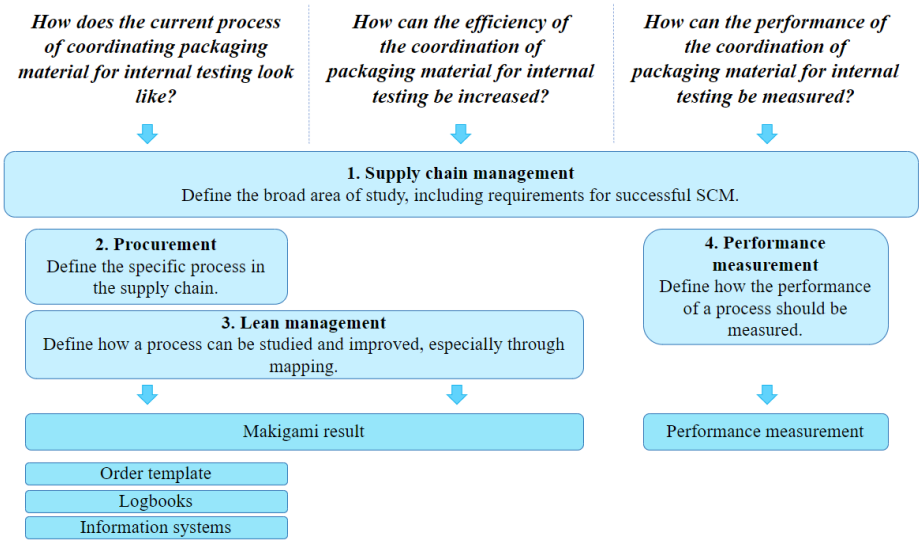

Figure 3-88: Illustration of the connection between the research questions, the investigation framework and the research results. (Own illustration)

4. Empirics

This chapter presents the results that have been generated through this case study. Firstly, the result from analyzing the logbooks is presented, including a compilation of all orders. Thereafter, the results of the current state and future state Makigami are shared. Linked to the illustration of the process, the information systems used within the process are also presented. Additionally, it describes how requests are performed by clients today. Lastly, the usage of performance measurement tools in the process is also described.

Note: all the numerical data are multiplied with a confidential factor X.

4.1 Logbook

The logbooks include historic data with all orders through the function TOMS. The data is sorted by three main categories corresponding to PackMat, AddMat and Design Request. Commonly for all three categories is that they include the following information: template no., order from date, requestor, project no., company buying and invoice. Other additional information is included for one or two of the categories, this is summarized in Table 4-1 below.

Table 4-1: Overview of the logbooks and what information respective category includes (X symbolize that the information is included).

Logbook	**- Template No.** **- Order from date** **- Requestor** **- Project No.** **- Company buying** **- Invoice**	**- New design (Yes/No)** **- Design No.**	**- Former design No.**	**- Material code**	**- CF**	**- Location client** **- PO No.**
PackMat	X	X		X	X	X
AddMat	X					X
Design Request	X	X	X	X		

4.1.1 Time interval and number of orders

The logbooks include order information for different time intervals. The time interval for each category is the following:

- PackMat: 2018-01-12 to 2022-12-07.
- AddMat: 2018-03-06 to 2022-04-04.
- Design Request: 2018-07-13 to 2020-11-30.

The distribution of orders over each category's time interval is presented in Table 4-2 below as a percentage of the total amount of orders for each category. Since all orders do not include a year in the logbooks, there are two different numbers for each category and year. The first number includes all orders, with and without an assigned year. For the orders without a year, the year is assumed by looking at the orders before and the orders after since the orders arise in ascending date. The second number includes only the orders with an assigned year, presented as a percentage of all orders for one specific year. For example, the first row for PackMat corresponds to 20,3%, meaning 20,3% of all the orders for PackMat were ordered during 2018, and 98,8% of these orders have an assigned year. In the bottom of Table 4-2 is the total number of orders presented for each category, meaning 96,2% of all PackMat orders have an assigned year.

Table 4-2: Distribution of orders for each category over each category's time interval.

Year	**PackMat**		**AddMat**		**Design Request**	
	Distribution of all orders	Orders with an assigned year	Distribution of all orders	Orders with an assigned year	Distribution of all orders	Orders with an assigned year
2018	20,3%	98,8%	24,6%	100%	17,5%	86,7%
2019	24,1%	97,4%	24,7%	98,4%	36,0%	100%
2020	19,9%	96,6%	23,9%	97,2%	46,5%	95,0%
2021	20,2%	92,0%	20,6%	78,3%	0%	0%
2022	15,5%	96,0%	6,2%	89,1%	0%	0%
SUM	*100%*	*96,2%*	*100%*	*93,8%*	*100%*	*95,3%*

When presenting the number of orders for each category in percentage, some information is lost. What the result exclude is that there are differences between the number of orders between the three categories. The logbook including PackMat orders is by far the biggest, including five times more orders than the logbook for AddMat and over 20 times more orders than the logbook for Design Request. Further, the difference between the results including all orders and the result including orders with an assigned year is not significantly large compared to the total number of orders in each category. Additionally, there is no major difference between the distribution of orders over the months of the year.

4.1.2 Distribution of orders

Tetra Pak is divided into nine different departments. The distribution of orders between these nine departments, for each of the three logbooks, is presented in Table 4-3. Notable, the orders without requestor or buying company are excluded in this result when the information could not be assumed.

Table 4-3: The departments at Tetra Pak and distribution of orders of PackMat, AddMat and Design Request.

Department/Distribution for	PackMat	AddMat	Design Request
Department A	0%	12,3%	2,0%
Department B	11,0%	2,5%	15,1%
Department C	24,2%	39,1%	34,2%
Department D	0,5%	0,6%	0%
Department E	57,4%	45,3%	48,7%
Department F	0%	0%	0%
Department G	0%	0%	0%
Department H	6,9%	0,1%	0%
Department I	0%	0%	0%
SUM	*100%*	*100%*	*100%*

The distribution of orders is similar for the three logbooks. The majority of orders are from Department E and from Department C. Thereafter, the order differs. However, it can be noted that Department F, Department G and Department I do not request any packaging material. For Design Request, there are no orders observed for Department H either. Furthermore, no orders from Department A requesting PackMat.

The purpose of the order for each of the clients, under each department, is presented in detailed for each client and logbook in Appendix E. There are in total 14 different *types* of clients requesting PackMat, 12 requesting AddMat and 11 requesting Design Request. Commonly for all clients, the purpose of order is one the following:

- Project testing.
- Development.
- Need for new/updated design.
- Testing machines to ensure the right quality before delivering to customers.
- Customer projects.
- Testing renovated, buy-backed Tetra Pak machines.
- Training courses.
- Solving service issues and claims.
- For a sample shop.

4.1.3 Other results from the logbooks

It has been noted for the logbook including PackMat orders that around 20% of the orders require a new design. It has also been noted that there are several different material codes that have been ordered for PackMat and several different material codes for Design Request.

The different CF used for PackMat show that there are several different CF, where almost all CF handle both new and old designs. The three CF that take the most orders have more than 10% each

of the total number of orders. It can be noted that only the order with an assigned CF have been included in this result.

The last result from the logbook is an overview of the different client's locations ordering packaging material, for the logbook PackMat and the logbook AddMat. It is concluded that there are several different locations used for PackMat and AddMat.

4.2 Makigami results

This section presents the relevant results of the phases leading up to the creation of the current state Makigami, as well as the actual map and the calculated indicators based on it.

4.2.1 Basis for Makigami analysis

To create the current state Makigami, a number of phases were performed. These phases are further elaborated on in chapter two, *Methodology*, under *2.5.1.1 Makigami analysis*. As a foundation for the analysis to be made, the process boundaries were identified and are explained in chapter one, *Introduction*, under *1.5 Focus and delimitations*.

Through the conducted interviews, the quality factors for each function participating in the process, and how to measure these, were determined. These are presented in Table 4-4 below.

Table 4-4: Functions involved in the Makigami process map and their corresponding quality factors, as well as how to measure this.

Function	Quality factors	How to measure quality factors
Client	Correct quantity and quality.	Check quantity and quality.
	On-time.	Estimated Time of Arrival (ETA).
	Balanced inventory.	Inventory levels, scrapping.
TOMS	Correct information.	Accuracy in information.
	High response speed.	Lead time, resolution time.
Planning Leader	Correct information about cost.	Accuracy in information.
TPI	Correct information in invoice.	Number of intermediate documents, resolution time.
CF	Correct information about requested packaging material.	Accuracy in information.
Design HUB	Correct information in design request.	Accuracy in information.
Material and capacity planners	Correct information about material availability.	Accuracy in information.
Supply chain control tower	Correct information about transport.	Accuracy in information.
MDM	Correct information about master data.	Accuracy in information.
	Lead-time.	Lead time, resolution time.
Coding and specifications	Correct information in requests for updates.	Accuracy in information.
Custom clearance	Correct information about shipment.	Accuracy in information.
Supply coordinator	Correct information.	Accuracy in information.
Warehouse	Correct information about inbound and outbound deliveries.	Accuracy in information.
	Warehouse capacity.	Inventory levels.
Transport	Correct information about shipments.	Accuracy in information.

The process performance indicators were then determined, and these are presented in Table 4-5 below.

Table 4-5: The performance indicators of the process illustrated in the Makigami.

Performance indicator category	Performance indicators
Lead time	Accuracy of ETA.
	Waiting time.
	Total process time.
Accuracy in delivery	Quality.
	Quantity.
Information accuracy	Information accuracy.
Inventory	Scrapping.
	Inventory levels.

The data collection set up to collect information for the Makigami is presented in chapter two, *Methodology*, under *2.4 Data collection*.

4.2.2 Current situation

From the pre-work the current state Makigami is created. The finished Makigami can be seen in a zoomed-out version in Appendix F. The Makigami includes detailed description of the process for each function. All activities are connected with communication lines, green lines for when the information flow, in most cases, is correct and on time. Red lines are used if the information flow in most cases, is incorrect and late. Further, all activities are tagged with red and green dots depending on if it is a value added or non-value-added activity. An activity is value added depending on the three factors of: if it is part of the product, legal regulations or if the activity results in customer satisfaction. The customer for this case is the internal client requesting packaging material. Customer satisfaction is then determined based on whether the activity ensures material arrives on time in full.

The Makigami illustrate every activity and transfer of information in the process with creates a large excel file with a high number of communication lines. To create an overview of the process, Figure 4-1 includes the major activities founded in the current state Makigami. The figure is based on *Figure 1-2: A simplified process of coordination packaging material for internal at Tetra Pak* presented in chapter one, *Introduction*, under *1.2.3 Packaging material for internal testing*. The simplified process is illustrated in grey color in Figure 4-1 below. In the bottom of the figure, several additional activities are presented, which did not fit under any of the other steps.

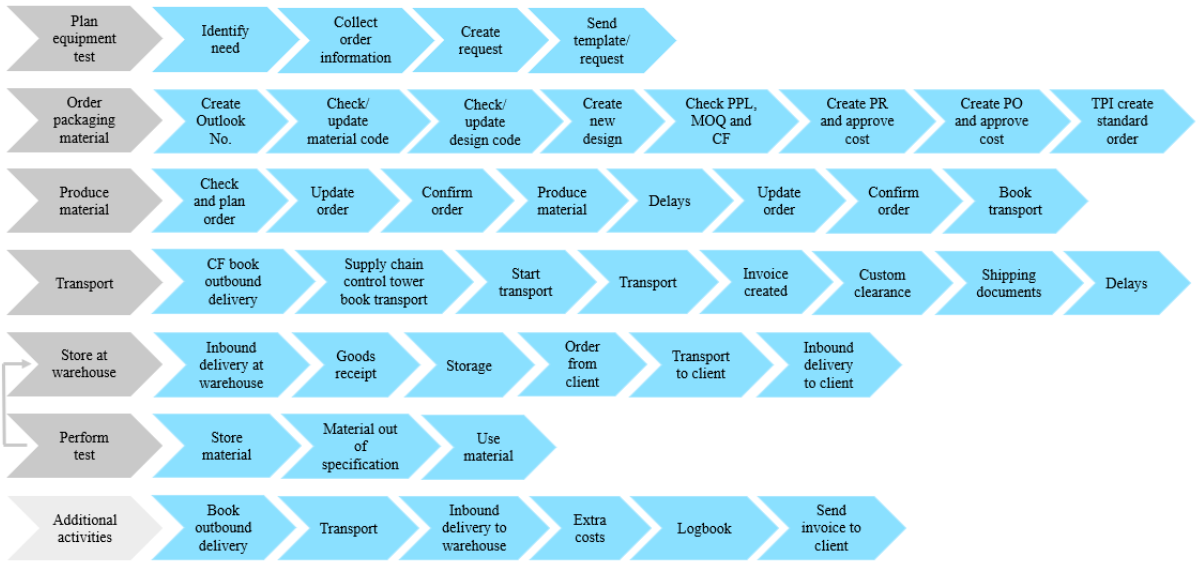

Figure 4-1: Simplified version of the current state Makigami process. (Own illustration)

To illustrate which functions that participate in each of the simplified process steps, Table 4-6 present the involved functions. The function TOMS, the Clients and CF are involved throughout the entire process.

Table 4-6: Involved functions in each of the simplified process steps.

Simplified process step	Involved functions
Plan equipment test	TOMS, Client, CF, MDM.
Order packaging material	TOMS, Client, CF, TPI, Design HUB, MDM, Planning leader, Material and capacity planners, Coding and specification.
Produce material	TOMS, Client, CF, Supply chain control tower, Material and capacity planners.
Transport	TOMS, Client, CF, Supply chain control tower, Custom clearance, Supply coordinator, Transport.
Store at warehouse	TOMS, Client, CF, Supply chain control tower, Warehouse, Transport.
Perform test	TOMS, Client, CF, Warehouse.
Additional activities	TOMS, Client, CF, TPI, Warehouse, Transport.

4.2.3 First improvements

The performance of the current state Makigami can be illustrated through calculating indicators. These are presented in the sections below.

Transfers, actions and documents

The number of transfers and actions for each function in the current state Makigami are presented in Table 4-7 below.

Table 4-7: Number of transactions and actions for each function included in the current state Makigami.

Function	Number of transfers	Number of actions
Production A	46	62
Production B	58	76
Production C	45	59
Development and Technology (D&T) D	47	61
D&T F	48	61
D&T C	49	61
D&T D	49	63
D&T D	51	66
Client G	49	61
Client F	46	54
Client E	52	62
TOMS	94	120
Planning leader	2	2
TPI	24	32
CF	52	69
Design HUB	7	14
Material and capacity planners	6	9
Supply chain control tower	13	15
MDM	15	23
Coding and specifications	4	8
Custom clearance	5	7
Supply coordinator	14	15
Warehouse	8	17
Transport	8	21
SUM	*792*	*1038*

A total of 406 documents are used in process presented in the current state Makigmi.

Lead-times

The total process time, the total action time, the total VAT and the total losses are calculated for each activity in the current state Makigami. These can be seen in Appendix F. The process's lead-times are presented for the current state in Table 4-8 below. It can be noted that the total process time for the current process is three and a half months with 21 days total action time, three days VAT and 18 days of total losses.

Table 4-8: Lead-times current state Makigami.

	Total process time	Total action time	Total VAT	Total losses
Hours	2490,2	504,3	73,0	431,3
Days	103,8	21,0	3,0	18,0
Month	3,5	0,7	0,1	0,6

Buffer factor = Total process time / Total action time = 4,9 < 30 OK!

In the current Makigami, several exceptional cases are included to describe several possible scenarios. These do not necessarily occur every time an order goes through the process and therefore a *best current state case scenario* is created. If all activates that are not supposed to happen are removed from the current state Makigami process, the following activities could be removed:

- No communication before the template is sent to TOMS about, for example, test requirements with CF.
- Existing material code and design.
- PPL included in template.
- Master data included (no error in SAP).
- The price is included when the order reaches TPI.
- The chosen CF approves/confirms the order.
- No delays during the process, for example, in production or during the transportation.
- No extra storage.

The new lead-times for *a best current state case scenario* are presented in Table 4-9. A new total process time is around one and a half months, 16 days of total action time, around one and a half days of VAT and 15 days of total losses.

Table 4-9: Lead-times for a best current state case scenario.

	Total process time	Total action time	Total VAT	Total losses
Hours	1128,8	391,5	37,4	354,1
Days	47,0	16,3	1,6	14,8
Month	1,6	0,5	0,1	0,5

Buffer factor = 2,9 < 30 OK!

Since the transport time varies between different clients, a new *best current state case scenario* is created with reduced transport time to one week instead of four weeks. This gives new lead-times for *a best current state case scenario*. These are presented in Table 4-10 below. A new total process time is reached with around one month, around 6 days of total action time, around one and a half days of VAT and 15 days of total losses.

Table 4-10: Lead-times for a best current state case scenario with one week transport time instead of four weeks.

	Total process time	Total action time	Total VAT	Total losses
Hours	624,8	139,5	37,4	102,1
Days	26,0	5,8	1,6	4,3
Months	0,9	0,2	0,1	0,1

Buffer factor = 4,5 < 30 OK!

The clients have expressed total process time during the interviews by answering the following question: *"How long before do you place the order for it to arrive on time?"*. The results are summarized in Table 4-11 below.

Table 4-11: Total process time expressed by clients.

Client	Total process time
Production A	1 month
Production B	2-3 months
Production C	3 months
D&T	*Best case:* 1-2 weeks (from sent order to delivery of goods) *Worst case:* 2-3 months
Client E	2-3 month

Basic conditions and standards

The last step of presenting the current Makigami is describing the Tetra Pak standards which must be considered. In the event of adjustment of the process, these are aspects that should be taken into account. The basic conditions and standards are listed below:

- All functions must be included.
- SAP is the used ERP globally at Tetra Pak.
- Consider environment and cost when selecting transport method.
- Expiration of packaging material and hence cannot be used for test.
- Two steps of cost approval. First approval by the project owners for projects. Second approval by the Planning leader for costs over a certain amount of Euros.
- Consider regulations, e.g., Custom clearance.
- Follow the high-level process.

4.2.4 Final process

This section presents the relevant results of the phases leading up to the creation of the future state Makigami, as well as the actual map and the calculated indicators connected to this.

Makigami future state map

To create the future state map, only value-added activities were transferred initially. Thereafter, the process was checked to ensure it was still functioning. The process was adjusted with the intention of reducing lead times, the number of activities and transfers as well as reducing the complexity of the process. The results, consisting of the Makigami future state, can be seen in Appendix G. Likewise the current state, communication lines and dots, depending on if the activity is value added or not, is included.

The current state Makigami overview illustrated earlier in this chapter, under *4.2.2 Current situation*, in *Figure 4-1: Simplified version of the current state Makigami process*, is still applicable for the future state map. This is the case since none of the major activities are removed from the process. However, for example duplicated work and unnecessary communication loops within major activities are removed. This result in a total of less actions and transfers. Furthermore, since no major activities are removed, the result in *Table 4-6: Involved functions in each of the simplified process steps*, under the same section, can also be applied for the future state with one exception. Material and capacity planners are not involved within the simplified process step Ordering packaging material in the future state. This is one of the removed activities further elaborated on in the next chapter, chapter five, *Analysis*.

Transfers, actions and documents

The performance of the improved Makigami can be illustrated through calculating indicators. The number of transfers and actions for each function in the future state Makigami are presented in Table 4-12 below.

Table 4-12: Number of transfers and actions for each function included in the future state Makigami.

Function	Number of transfers	Number of actions
Production A	42	62
Production B	46	64
Production C	40	58
D&T	47	69
Client G	47	69
Client F	44	62
Client E	44	63
TOMS	69	84
Planning leader	2	2
TPI	20	26
CF	37	62
Design HUB	6	13
Material and capacity planners	2	4
Supply chain control tower	10	11
MDM	9	17
Coding and specifications	4	9
Custom clearance	7	9
Supply coordinator	8	9
Warehouse	6	13
Transport	7	21
SUM	*497*	*727*

Table 4-13 below presents the difference in number of transfers and actions, when comparing the current state to the future state map.

Table 4-13: Comparison of transfers and actions between the current and future state.

Function	Difference in number of transfers	Difference in number of actions
Production A	-4	0
Production B	-12	-12
Production C	-5	-1
D&T	-2	+7
Client G	-2	+8
Client F	-2	+8
Client E	-8	+1
TOMS	-25	-36
Planning leader	0	0
TPI	-4	-6
CF	-15	-7
Design HUB	-1	-1
Material and capacity planners	-4	-5
Supply chain control tower	-3	-4
MDM	-6	-6
Coding and specifications	0	+1
Custom clearance	+2	+2
Supply coordinator	-6	-6
Warehouse	-2	-4
Transport	-1	0
SUM	-100	-61

Through making an improved Makigami map of the future state most functions reduce the number of transfers in the process. For the number of transfers and actions from D&T in the current state the average was calculated to be able to compare to the numbers for the future state. The exceptions are that Coding and specification and Planning leader remain the same, while for Custom clearance two transfers are added. The largest reduction in actions and transfers is for TOMS. The total reduction in transfers is summarized to 100. The total reduction in actions was calculated to 61.

Additionally, a total of 312 documents are used in the process presented in the Makigami future state. Consequently, 94 less documents than in the current state.

Lead-times

The total process time, the total action time, the total VAT and the total losses are calculated for each activity in the bottom of the future state Makigami. These can be seen in Appendix G. The whole process's lead-times are presented for the future state in Table 4-14 below.

Table 4-14: Lead-times future state Makigami.

	Total process time	Total action time	Total VAT	Total losses
Hours	2018,1	482,3	72,3	410,1
Days	84,1	20,1	3,0	17,1
Months	2,8	0,7	0,1	0,6

Buffer factor = 4,18 < 30 OK!

The difference between the current and future state Makigami, with respect to lead-times, are presented in Table 4-15.

Table 4-15: Makigami lead-times for current and future state including the improvements.

	Total process time	Total action time	Total VAT time	Total losses
Current state (h)	2490,2	504,3	73,0	431,3
Future state (h)	2018,1	482,3	72,3	410,1
Improvement (h)	472,1	22,0	0,8	21,2
Improvement (days)	19,7	0,9	0,03	0,9
Precent of current	19,0%	4,4%	1,0%	4,9%

It can be noted that 1% VAT has been removed from the current state. This is because of the following factors:

- Some activities arise more than once in the current state and since a *standard* flow is created these activities only arise once in the future state.
- Some activities arise in parallel in both the current and future state. In these cases, only the activity with the largest process time is exposed. Since activities can arise in different places in current and future state, the VAT have been influenced.

As for the current state, a new *best future state case scenario* is created for the future state Makigami. The new lead-times for *a best future state case scenario* are presented in Table 4-16.

Table 4-16: Lead-times for a best future state case scenario.

	Total process time	Total action time	Total VAT	Total losses
Hours	1114,5	391,9	37,4	354,5
Days	46,4	16,3	1,6	14,8
Months	1,5	0,5	0,1	0,5

Buffer factor = 2,84 < 30 OK!

Further, a new *best future state case scenario* is created with reduced transport time to one week instead of four weeks. The corresponding lead-times are presented in Table 4-17 below.

Table 4-17: Lead-times for a best future state case scenario with one week transport instead of four weeks.

	Total process time	Total action time	Total VAT	Total losses
Hours	610,5	139,9	37,4	102,5
Days	25,4	5,8	1,6	4,3
Months	0,8	0,2	0,1	0,1

Buffer factor = 4,36 < 30 OK!

4.3 Information systems

When conducting interviews and performing observations, all identified information systems used by the functions involved in the coordination of packaging material for internal testing were noted. These are presented in Appendix H. For each information system, the purpose of that specific system is described. Notable is that other functions within the system which are not specifically applied in this process are not included. The stakeholder using the system is also presented. The systems referred to in interviews and observations have been noted, however there may be additional systems used in the process that have not been mentioned by participants.

There are a number of information systems used in the process of coordinating packaging material for internal testing. The setup of systems used in the daily workflow depends on geographical location. Further, clients use different methods for execute requests and find information. For example, one production site is more automated than others through more efficient use of Warehouse Management System (WMS) and ERP. Another example is that the warehouses use different WMS systems depending on location. This means that different functions use different systems in their daily work processes. Linked to the WMS systems, it has also been described that one of them lacks in level of accuracy. This means that the actual stock levels do not always correspond to reality. This is described in part as being due to inbound operations not being performed correctly at all warehouses. These aspects are further elaborated on in the current state Makigami in Appendix F.

4.4 Order template

To understand how packaging material is requested, 17 requests from clients, belonging to different departments, were studied. Requests for packaging materials are today made in two general ways. In most cases, a template is emailed to TOMS that aims to contain all necessary information to make a correct order. Today, two different formats of these templates, template one and template two, are used by clients. Template one is used by three of the investigated requests and is an old version of template two. The updated version, template two, is used by 13 of the investigated requests. If a template is not used, an email is sent containing an already existing PR, material code, quantity, ETA, production plant and delivery address. This is used only by Production B.

An identified pattern among sent templates is that several do not include all required information. Based on the required information in template two, 15 out of 16 requests via template are missing information. Only one of the templates investigated requested a new design, which included all necessary information in that section. The result from the investigated order template is presented in Table 4-18 below, which includes the number of investigated templates that miss information.

Table 4-18: Results of order template analysis.

Information required		**Percentage of times missing information**	**Number of templates missing information of total**
General information	Requestor name	6.3%	1/16
	Company buying	6.3%	1/16
	Project number	6.3%	1/16
Material information	Material description (with material code)	12.5%	2/16
	Work In Progress (WIP) code	62.5%	10/16
	WIP description	62.5%	10/16
	Design code	18.8%	3/16
Quantity		6.3%	1/16
Supplier information	Production plant	31.3%	5/16
	Have the ordered been in contact with factory	37.5%	6/16
	Coordinator at production plant	68.8%	11/16
Delivery	Way of delivery	31.3%	5/16
	Requested delivery date	25.0%	4/16
	Delivery address	31.3%	5/16
	Goods marking	25.0%	4/16

For the table above, it can be concluded that none of the required information sections was included in all cases. Some information was missing to a much greater degree than others. Information that was lacking most was supplier information, such as coordinator at the production plant and information regarding whether the client has been in contact with the factory or not. Further material information such as WIP code and WIP description was also missing in a majority of cases.

4.5 Performance measurement

Based on interviews and observations the number of functions using performance measurements have been noted. This result is presented in Table 4-19 below. Participants were asked about KPIs, specifically related to the coordination of packaging material for internal testing. Potential KPIs used for other processes are hence not included in this report.

Table 4-19: Used KPIs for each function connected to the coordination of packaging material for internal testing.

Function	Using KPIs for internal testing	KPIs used
Production A	No	-
Production B	Yes	PackMat inventory management, planning and handling.
Production C	No	-
D&T	No	-
Client G	No	-
Client F	No	-
Client E	No	-
TOMS	No	-
Planning leader	Yes	Procurement operational cost, operational performance indicators.
TPI	Yes	Number of intermediate documents.
CF A	No	-
CF B	No	-
CF C	No	-
Design HUB	No	Number of repro orders, occasions and standard jobs (not specifically for internal).
Material and capacity planners	Yes	Perfect order (in time, in full).
Supply chain control tower	Yes	Perfect order.
MDM	Yes	Resolution time.
Coding and specifications	No	-
Custom clearance	Yes	Import activities, planning and handling.
Supply coordinator	Yes	Import activities, planning and handling.
Warehouse	No	-
Transport	No	-

For a majority of the functions, KPIs specifically used for the process of coordination packaging material for internal testing was not used. Some functions used metrics specifically for internal testing, but most did not have specific information linked to internal testing. However, most participants mentioned that they used performance measurement tools for other purposes. Often for external customers. In one case the function described that they did not know. Six functions expressed that they used KPIs specifically for internal testing.

5. Analysis

This chapter provides an analysis of the results generated from this case study. The structure of this chapter is similar to the previous chapter. The chapter thus consists of analysis of the following main topics: logbook, Makigami, information systems and performance measurement. Analysis of order templates is woven into the Makigami section as it is closely linked to the description of the work processes. Finally, to compile the analysis and provide a basis for the recommendation in the following chapter, the solutions are analyzed based on an impact effort matrix and the countermeasure ladder.

5.1 Logbook

The three categories of logbooks used for collecting and storing historical data include largely the same kind of information. The main difference is between the number of orders under each category. The logbook for PackMat orders is by far the biggest. Even though the time interval is bigger for the PackMat logbook, the greater quantity of orders indicates that PackMat are more frequently requested. These orders are also prioritized within the TOMS function, at least when updating the order data in the logbooks. However, it can be noted that one order row in the AddMat logbook can correspond to more than one order, while the PackMat logbook only has one order per order row. Despite this knowledge, the number of orders of PackMat is larger than AddMat.

The three different requests follow somewhat the same process. The only difference between the process for PackMat and AddMat is the packaging material being requested. All presented activities in the current state Makigami applies to both types of requests. The same goes for Design Requests, which also follow the same process, but this process stops after a new design is being created. Similarities in a process's flow is favorable when redesigning a process since some of the useful strategies presented by Persson (1995) could be applied. These correspond to redistributing or increasing frequencies, eliminating or adopting to expected pattern of demand and simplifying structures, systems and processes in the future state Makigami.

For PackMat orders, 20% of the orders require a new design. As seen in the Makigami map, this requires a longer process flow including additional collaborations and activities between several functions. With a higher number of activities, the complexity and process time increase (Makigami Methodology 2021). Since these additional activities occur for several of the orders that goes through the process, this sub-process is important to include when redesigning the process in the future state map. All blockages, interruptions and rework in the flow are diverse types of non-value adding waste in the process (Liker 2020; Kadarova and Demecko 2016). The desire, when using Makigami, is to reduce waste throughout the value flow (Makigami Methodology 2021).

5.1.1 Clients

The logbooks have provided useful insights regarding the clients involved in the process. This has been used to identify the number of clients that request packaging material, and where in the organization they belong. Further investigation has shown that the clients have varying order purposes. These are necessary to make visible to understand the clients' diverse needs and the complexity of the process. A map is a powerful tool that can be used to visualize a complex reality, but including too many details can provide an ineffective perspective (Gardner and Cooper, 2003). The current state map includes several details necessary to understand the process. These are further standardized, especially for the clients, in the future state map. Thereby creating a more effective perspective of the process.

As expressed earlier in the research, an increased understanding, and thereby visibility, of the entire process was a desire of the project. Creating visibility is a vital part within supply chain integration (Stone 2004). The Makigami analysis, in itself, does increase the visibility of a working process (Makigami Methodology 2021). In addition to this, the three logbooks have provided visibility of the involved function. To create an improved future process, it is important to identify all the functions involved (Tonkin 1997). CF and the clients, including their order purpose, have been identified and thus have been made more visible.

In all the categories within the logbooks, order data is sometimes missing. This is, for example, shown in *Table 4-2: Distribution of orders for each category over each category's time interval*, under *4.1.1 Time interval and number of orders,* where some of the orders miss date information. To create an overview as correct as possible of all orders through the function TOMS, all rows are considered. However, there is a risk that some orders have been missed, which could result in additional clients. For example, some orders could not be connected to any requestor or to any of the departments. In addition to this, the logbook for AddMat has not been updated since April 2022 and the logbook for Design Request since November 2020. Orders after these dates are not included in the research. Since the order requests are recurrent, the missing order information do not have a significant effect on the result. However, it is recommended to update the result to reassure that no new clients have emerged with new needs.

5.2 Makigami map

In the following section the result of the current state Makigami will be analyzed. Based on this analysis, it is elaborated how the future state Makigami was created. The analysis will first be made on a more general level to then be investigated separately based on the separation of clients, TOMS and collaborators.

5.2.1 Makigami current state

This section addresses the Makigami analysis from a holistic perspective. Therefore, it provides general aspects applicable for all functions involved in the process of coordinating packaging material for internal testing.

5.2.1.1 Collaboration

The current process map consists of many functions and activities that create a need for a vast number of transfers and several documents. Due to the structure of the process involving several functions, a need for effective cooperation is created. What has been identified, however, is that there are shortcomings in collaboration. Firstly, there is a lack of understanding between the involved functions about their individual work process, which highly correlates to poor cooperation (Stone 2004). Further, waiting times can be long and information often needs to pass through several functions before it ends up with the right person. This correlates to shortcomings in cooperation as poor communication slows down the process (Makigami methodology 2021).

The core issue creating shortcomings in cooperation is a lack of process understanding and sufficient knowledge of where to find information and who to contact to reach it. Regarding the number of transfers and activities, a great emphasis is placed on TOMS. A large quantity of activities and transfers concerns transmitting information through different parties in the chain. This results in blockages, interruptions and rework in the flow and therefore form non-value adding waste in the process. (Liker 2020; Kadarova and Demecko 2016) This in turn results in process loss through unnecessary and duplicated work (Makigami Methodology 2021).

Creating good cooperation is crucial to increase flexibility, improve customer satisfaction and quality, reduce costs, increase control and profits. Further, it enables better use of resources and competence. (Naslund and Williamson 2010) When improving the process flow, the emphasis has therefore been on ensuring that the right information is accessible for the right people. Through this strategy, activities that are due to loss of information, often resulting in duplicated activities, are removed (Makigami Methodology 2021). Furthermore, more time is freed up for functions that act as problem solvers, such as TOMS, to instead enable better use of their competence.

Connected to collaboration, geographical location is also an aspect to consider. As a result of involved functions being spread globally, different time zones risk delays in the process. Furthermore, there are also language barriers to consider that can make communication more difficult and can hence lead to decisions loss through miscommunication. (Makigami Methodology 2021) However, this is not something that has been highlighted as a decisive problem. Nevertheless, for a global company like Tetra Pak, it is essential to ensure that the communicational risks of being geographically spread are minimized by enabling seamless collaboration.

5.2.1.2 Complexity

When mapping the process, it is difficult to describe it in a simple and concrete way. The process can be experienced as hard to understand, with a complex flow, including several functions, individual- and sub-processes. Complexity in the process is problematic since a non-standardized process increases the risk of motion loss (Makigami Methodology 2021). Due to identified risks with large complexity, an aim with the improvement was to form a more standardized process.

In addition to the complexity there is today a lack of training materials that enable for external actors to familiarize themselves with the process. Further, it is perceived as difficult to educate individuals in the work process due to the complexity. This is a shortcoming in the process as these difficulties can be harmful since the progress of the process is dependent on the availability of all people involved. This is connected to a skill loss as the process requires a specific person or specialist to succeed (Makigami Methodology 2021). A specific example is the team TOMS. Today, two people are working within the function. Without clear routines, the roles within TOMS are difficult to learn which creates a vulnerability in the process. Therefore, it is important to create clear routines, instructions and training material within this function to reduce vulnerability. In similarity, Coding and specifications express their activities as complex and difficult to learn. To minimize risks, a general recommendation is to share the Makigami process map as well as develop in-depth training material to increase understanding of the full process. If this is not achieved, a situation where staff is not available generates a significant risk to the coordination of packaging material for internal testing as it can lead to sectionalism through an unbalanced work volume and errors in the process (Makigami Methodology 2021).

5.2.1.3 Total process time

It can be concluded from the result that the total process time is long, and especially inconsistent. This means that clients today need to order well in advance to ensure delivery at the right time. Due to several exceptions that needs to be considered, there was a need to separate lead-times according to different scenarios. These scenarios could for example be whether the template sent from clients is missing information or if delays occur in the process.

Depending on if these exceptional cases occur or not, lead-times differ largely and hence illustrate the complexity of the process. A concrete example is the time to get an order through the system. At best this process can take ten minutes if all the necessary information is available. If this is not the case, communication loops need to be created, as well as manual work, to allow for the process to succeed. Therefore, the same process can also take 30 days. Reasonably this results in speed loss through excessively long lead times (Makigami Methodology 2021).

It can be noted that the buffer factor is OK, under 30, indicating that the relation between total process and action time is not the main issue for all analyzed scenarios. Therefore, this is not further investigated. An ideal flow is value added from start until the delivery to the customer. However, this is not the case for the current state Makigami even though the buffer factor is low. An aim in the future state map has therefore been to eliminate blockages, interruptions and rework in the flow. (Liker 2020; Kadarova and Demecko 2016) The strategy was hence to eliminate exceptional cases, when possible, to improve the flow. As previously mentioned, an example of exceptional cases that can be eliminated are communication loops that occur as lack of access to information. Further examples will be presented later in the chapter.

5.2.1.4 Lack of knowledge

Connected to the difficulties in simplifying the process and lack of training material, it has been further identified that there is a lack of understanding internally of what other functions do and what their work processes look like. On a high level, there is a lack of understanding from the Planning leader and manager. Not being able to create a full understanding of a work process is problematic as it is important to be able to give the right support and identify shortcomings and advantages in the work process (Makigami Methodology 2021).

Furthermore, it is expressed in interviews that there is a lack of understanding between the functions involved. Poor knowledge of other sections' demands is highly connected to poor cooperation (Stone 2004). Lack of understanding of how other processes within the chain work risks resulting in silos arising where individual goals are prioritized (Naslund and Williamson 2010). If there is a lack of understanding, a holistic approach is difficult to hold. A holistic approach is a key component in a collaborative supply chain. This is further important since the performance of the supply chain is determined by the execution of all members involved. (Naslund and Williamson 2010)

If not increased visibility between functions is created, it increases the risk of negative effects such as poor performance and lack of collaboration. Tetra Pak can find great gains in counteracting factors mentioned above through increasing visibility in the process. This can be achieved through creating material for sharing between functions to increase knowledge of the full process, and not just one's specific daily tasks. (Stone 2004) Additionally, successful integration between functions can help reduce rework and hence project costs (Naslund and Williamson 2010).

5.2.1.5 Planning

In addition to the fact that the process is difficult to concretize, it also makes it difficult for functions within the process to plan. This problem arises due to the large variety of possible scenarios throughout the process. Furthermore, with a great risk of various event occurring that affect the flow, uncertainties are created. As previously mentioned, focus is therefore placed on eliminating events occurring that create uncertainties.

Planning is further complicated by the fact that there is currently no full-scale forecasting for packaging material for internal testing. However, it is worth mentioning that forecasting is applied for commissioning, which is testing at the external client’s site. Currently, improvement is however being made to simplify planning as forecasting is under development. Forecasting is recommended as it is a technique that can be used to reduce different types of uncertainties (Persson 1995). Further it can help eliminate decision loss, such as decision delay and reduce number of processes for decisions making (Makigami Methodology 2021). To decrease difficulties in planning, forecasts for internal testing would facilitate the process of coordinating packaging.

5.2.2 Clients

When analyzing the clients separately and as one function, their processes clearly differ. Furthermore, the differences are bigger in the beginning of the current process than in the end. As presented in the result *4.1.2 Distribution of orders* there are many clients from different departments and with different order purposes that order packaging material. Additionally, as seen in the current state Makigami, there is no standard process for clients to follow. This allows clients to *create* a request in their own way. This can be one reason behind the result presented in *4.4 Order template*. More precisely, the process of searching for information to include in the template is accomplished in diverse ways. In addition to the information varying, different templates are also used to carry out a request which creates inconsistency in the process.

When information is missing already in the beginning of the process, new activities are created to solve the missing information from the templates. One solution for this problem is to remove the option to send an incomplete template. This can be feasible with a system where all fields must be filled in correctly to proceed. A drop-down list to search for existing variations of information would be favorable to reduce the risk for incorrect information and incorrect requests. This creates the possibility for the requester to directly search and select information in an electronic catalog (Puschmann and Alt 2005). An alternative solution could be to send back all incomplete templates to the client. This is not in place today, due to TOMS services minded approach and the clients' behaviors. For both solutions to be sustainable, it is important to give the client the right instructions. Instructions for finding the right information, instructions for how to fill in a correct template and instructions on how to create a correct order request.

With clear instructions, several activities in the current state can be removed from the process. Especially, communication loops with questions before the request is sent and communication loops arising later in the process due to missing information. The process is therefore redesigned with Persson's (1995) strategies of simplifying structures, systems and processes, in this case for the client. This results in less rework, less handling and a reduced number of unnecessary movements, meaning less time spent on searching, reaching or looking for various kinds of information (Liker 2020). However, activities have also been added for some clients in the future state map to create a correct order request with all necessary information in the template. Determine factory is one example of one added activity for all clients.

Categorizing clients

Despite the large number of clients from different departments, the clients can be divided into two general categories: one for production and one for all other clients. Normally, the flow for packaging material orders for production is easier since these requests include *standard* packaging material. This means that the orders are recurrent, normally without new designs and no *specific* requirements. The other orders are scattered over more departments, normally with specific requirements and new designs. Therefore, the number of activities increases, and the process flow becomes more complex (Makigami Methodology 2021). Example of these additional activities are

that the test requirements need to be aligned with the CF through meetings, approval of costs from project owners, sometimes participating in testing at CF and that extra costs may occur at the CF. Consequently, it is necessary to create two types of *standard* flows in the future state Makigami, one for production and one for all other clients.

The production flow can further be divided into one manual- and one automated flow. The automated flow, only used by Production B, facilitates the process of searching for information before sending the request to TOMS. For the manual flow, the request is sent with a template and the process to find the right information to include is more time-consuming and complex. The automated flow is therefore beneficial since it also facilitates activities later in the process. This is also stated by Kim and Shunk (2003) who explains that it can yield significant efficiencies, time and cost savings by supporting and automating the procurement process. However, automated replenishment systems require sufficient information regarding the demand available and material sources that are reliable and secure. Various system does also need to be implemented in a hybrid and seamless manner, including a high level of support and system provision for the end-user. (Brandon-Jones 2017)

Future state process

For all the clients that do not order for production, communication with production is one important activity added in the future state. Collaboration between the different production sites is beneficial, not only in case of crisis during unavailability of material, but also to utilize packaging material, especially with shorter expiration date. This allows for a better-balanced inventory with less scrapping, and accordingly less waste (Ali et al. 2019). Additionally, less inventory allows for a better flow where problems effectively can be controlled as they occur (Liker 2020).

Since all packaging material has a Minimum Order Quantity (MOQ), the ordered quantity can be higher than the requested quantity. This means that there can be packaging material left after the test has been completed. By increasing the collaboration between functions and utilizing packaging material no longer needed for one client, scrapping and costs will be reduced (Min et al. 2005). In addition to this, waste will be reduced in the form of less overproduction and less excess inventory (Liker 2020). It is also possible that the process time could be decreased since the packaging material is already available to be used or shipped to the right client. However, this is only possible when ordering *standard* packaging material.

Connected to balancing inventory, regular inventory checks are also concerned. Noted from the interviews, inventory checks must be done along with tagging goods in the same way to ensure that goods can be tracked easily. For Production B, inventory is regularly checked to ensure that the data matches the actual stock. It proves to be effective to ensure that the inventory is kept balanced and accurate. Furthermore, it has been shown that some warehouses store material well above its expiration date and hence take up unnecessary storage volume. To counteract this, it is therefore important that clients routinely check their inventory to ensure accuracy, but also to remove excessive material that no longer is usable for tests.

For special test requirements, communication with the CF is important to ensure that the packaging material ordered is as desired. In addition to this, a design sketch can be useful for advanced designs to make it easier to understand. Consequently, communication with CF has been added in the future state for all clients with special test requirements and a design sketch has been added for all D&T clients, normally requesting new advanced designs.

In the current state, Production B is the only client receiving information about order confirmation, invoice documentations, notifications when the transportation is booked from warehouse to site and notifications when the material arrives to the site. This is information all clients want to receive. Therefore, the process should in this case be standardized for all clients, meaning TOMS should send order information to all clients. Concerning the transport and arrival of goods, the warehouse system should send out automatic notifications about every status update of the order. This is something that the client can choose to turn on and off in the system. This information should be clear and presented with instructions to ensure that all clients are aware of how the system works. High level of support and system provision for the end-user is for this case necessary (Brandon-Jones 2017).

Further, all clients should use the warehouse system to see order stock and book delivery from the warehouse to the client's site. Unnecessary loops of communication between functions can be removed in the future state if the client used the warehouse system by themselves instead of asking for the answers. For this reason, it is important to keep the inventory levels in the warehouse system on the same level as the physical inventory stock. Additionally, to give the clients the possibility to find information by themself, access to systems, including instructions and training, should be provided (Brandon-Jones 2017). This applies to the tracking systems used to track goods before they reach the warehouse. Furthermore, databases, invoice documentation and order confirmations should also be available, if possible, for all clients. This will reduce communication loops needed to find order status or other necessary documentation in the current process. This in turn will reduce waste in the form of less unnecessary movement (Liker 2020). If access cannot be given to the clients, it is important to communicate information and changes when they arise.

From the interviews, some clients stated that the packaging material need to be stored at site for several days before being able to be used for testing. This is since the packaging material must be cooled down as material is stored at too hot temperatures at warehouses today. This can be the case for all clients if the test material has specific requirements. This can be avoided with upgraded warehouses enabling right conditions. On the other hand, it generates a cost that can be greater than the profit earned through reducing the additional lead time of a cool-down process.

Lastly, all clients should follow the *standardized* flow presented in the future state. This means no client should leave any activities assigned for them to another function in the process. When leaving activities for another function, additional activities are created, normally harder to complete than for the function assigned to accomplish them. This in turn increases the number of transfers, actions and the total process time.

5.2.3 TOMS

It is clear, from the Makigami map, that the function TOMS has a vital role in the process for coordinating packaging material for internal testing. With almost more than double transactions and actions compared to all other functions in the process, a lot of information goes through this function. This creates long email conversations, back and forth between several functions and people. Hence, TOMS works as an intermediator in the process and has an important mission to ensure that all information is available and aligned with the client's desire. Even though the client is responsible for providing the right information in the beginning, the function TOMS gives the service to correct and *fix* all problems that arise throughout the process. Today, their service has not been invoiced internally, in contrast to other functions. Consequently, the clients are comfortable with the service TOMS provides and often take advantage of this in the current process flow. Therefore, one recommended action is that TOMS invoice their service.

With TOMS services minded working style, the function is very well appreciated by all the clients. However, to create a more optimal process, correcting mistakes is not the right way to work. Clear instructions need to be created, including training when needed. (Liker 2020) The process needs to be well visible with clear roles and responsibilities, but understanding the roles and purposes of others should also be prioritized (Stone 2004). Information needs to be accessible for all functions concerned to facilitate the process (Naslund and Williamson 2010). For TOMS, this means they should not accept incorrect order templates. Instructions should instead be provided with training materials accessible to enable correct creation of requests. This applies for all functions during the process who send requests.

Future state process

With correct requests, several subsequent activities connected to missing information from the client can be removed in the future state process. However, the activity to check the received information is still required to minimize the risk of forwarding incorrect information and creating error further ahead in the process.

As described for the clients, TOMS should send order information to all clients where they are concerned. The same goes for invoice documentation which also should be sent to Custom clearance in combination with other additional documents necessary for them to accomplish their work tasks. This will reduce the communication loops arising when this type of information is missing.

Duplicated information should be avoided, a process loss identified in the current state (Makigami Methodology 2021). When one system sends out automatic notifications, there is no need for creating additional emails including the same information. This type of duplicated activity is removed in the entire process.

Additionally, one of the sub-processes, corresponding to *pre-checking* if one chosen CF can accept an order or not, has been removed in the future state. The information provided is not crucial

enough to weigh up for the increased process time the sub-process creates. If a CF cannot accept an order, Material and capacity planners will provide the help to find a solution.

It has been noted that the logbooks, filled in by TOMS, are not updated during heavy workload. The logbooks are not necessary to be updated for the process to work, but if the activity should be included in the process, the update should always be done.

From the current state Makigami, the visibility of the order is clearly lacking during the production of material at CFs and during transport. This creates additional communications loops in the process. Today, a large communication loop between several functions arises when the client has questions connected to the transport. This is due to the low access to CF and the transportation services information systems and due to low information sharing and collaboration between the functions. This problem has been expressed by several functions during interviews, and not only for the function TOMS. However, the Supply chain control tower has access to a tracking system, making the transport visible. All functions and people concerned should have access to this tracking system, with appropriate instructions and training. This would facilitate the process by removing large email conversations back and front between several people. In the future state, communication loops have been removed by giving the function concerned access to the right systems, which will reduce waste in the form of less unnecessary movement (Liker 2020).

5.2.4 Collaborators

Apart from the TOMS function, 13 other collaborators have been identified in the current process. All of them are necessary for the flow to work. Therefore, none of them are removed in the future state process. Overall, the sub-processes for each collaborator have not been changed significantly. The focus when redesigning the process has been on the activities the function TOMS is involved in, connecting different sub-processes together. Consequently, the individual sub-processes for each collaborator are sometimes not as detailed described as for TOMS's flow. Instead, the major activities are included. However, some changes have been made. These are analyzed below.

Missing information

In 50% of the cases, TPI is missing some type of information when the order reaches TPI's information system. Several similar sub-processes like this have been removed from the future state map, but not this one. Since information is missing half of the time for orders through TPI, this problem much be further investigated. In other sub-processes, information could be missed but not to the same extent. However, for all sub-processes, the amount of missing information could be reduced by carrying out all previous activities as correctly as possible. This will reduce process losses as unnecessary and duplicated work, speed losses as long lead-times, motion losses as manual work and duplicated checks, decision losses as miscommunication and defect losses as rework (Makigami Methodology 2021). As mentioned previously, instruction, access to systems and appropriate training, clear roles and responsibilities are requirements for the process to be improve. Furthermore, one additional solution could be to make it impossible to forward an order with incomplete information. An updated system with notifications alerts, can make it visible

earlier in the process that, for example, a design is not activated, master data is missing, price is missing or a potential need for extensions. This will reduce waste in the process (Liker 2020).

One example from the current process, connected to missing information, is that there are several potential activities needed when an order reaches Custom clearance. These activities arise when documents and information connected to the order are missing. Information needs to be shared for the process to continue. With a clear understanding of the process and other functions requirements, this problem could be avoided. Therefore, all necessary information and documentation are always sent in future state to Custom clearance from supply chain coordinators before the goods arrive at Custom clearance. Additional activities, for the Supply chain coordinator to have access to this information and documents in time, have also been added to the future process. This will reduce several communication loops from the current process connected to the Custom clearance, which in turn reduce waste (Liker 2020).

Future state process

A recurrent problem in the current state is delays. Delays can arise before or during production, or during transportation. Normally, delays occur without control and are hard to remove. Therefore, all potential delays are transferred and represented in the future state as well. The difference is that order changes and status updates are always communicated in the future state. When information is shared, several unnecessary communication loops could be removed from the current process which will reduce waste in the form of less unnecessary movement (Liker 2020).

Recently a collaboration with a third-party providing warehouse operations has started with newly implemented standard processes in combination with education for workers. Today, when goods arrive without required information, a *quarantine zone* is used. This creates delays for the client requesting the packaging material, because when goods are stored in the *quarantine zone* it cannot be entered into the system. This means that the goods have arrived, but the client cannot see the goods in the system. The zone has been removed in the future process state since all goods should include the required information. If not, the information should be easy to find following clearly implemented instructions. Consequently, unnecessary communications loops are removed in the future process state which reduce waste in the form of less unnecessary movement (Liker 2020).

After testing, the remaining material is transported and stored once again at the warehouse. The client needs to update the goods and remove the old marking to avoid double marked goods. This is important to be able to keep track of goods and to see the actual stock level of one specific good without losses in the form of rework, operation inaccuracy, decision delay and unnecessary work. The process of goods reception includes manual processes which is seen as a motion loss. This means a risk for output errors. (Makigami Methodology 2021) The following problem could be that the client cannot see that the goods have arrived. This could be avoided with more automated solutions (Kim and Shunk 2003). Another solution would be clear instructions, roles and purposes of others (Stone 2004).

CF

From the logbooks, several CF have been identified to be involved in the study's process. Three of them, those with the most orders, have been further investigated. The main activities are illustrated in the current state process. With previously stated improvements, corresponding to more visibility of the process, clear instructions and responsibilities, the majority of orders reaching the CF should be correct, including the right information. Even if problems can occur, the future state does not include, as a standard process, the activity of missing information and corresponding communication loops.

When the goods leave the CF, one important activity included in the future state is to send this information to TOMS and the client, including required documents. This will reduce the need for unnecessary communications loops arising in the current process today. Similar to order confirmation, the approvals are automatically forwarded in the system. However, this information is duplicated with a sent email as well. This duplication is kept in the future state process since it has been expressed by involved functions as a requirement in the process.

As mentioned earlier, forecasting would be a significant improvement for the coordinating process of packaging material for internal testing, especially from the CF point of view. The job of planning for production and purchase of base material needed to produce packaging material would be facilitated. This is one strategy mentioned by Persson (1995) to reduce or adapt to uncertainties by, for example, forecasting.

One additional improvement is to improve communication between the client and the factory. Understanding each other's needs and requirements would reduce errors in the process and thereby waste (Liker 2020). A meeting is a requirement in the future state process for all orders that are not *standard*, to align tests and the packaging material requirements.

5.2.5 Summary of changes

Based on the current state Makigami, a number of improvement areas have been identified. Several problems and losses were analyzed to find countermeasures. Based on this, a future state Makigami was created. From the result presented in *Table 4-12: Number of transfers and actions for each function included in the future state Makigami* and *Table 4-13: Comparison of transfers and actions between the current and future state*, under *4.2.4.2 Transfers, actions and document*s, several improvements could be possible by redesigning the process. The future state process includes 100 less transfers, 61 less actions and 94 less documents. This in turn results in an improved total process time, reduced by almost 20% from the current process.

The total action time and losses have also been reduced by around 20 hours each. The total VAT is nearly the same in both processes, which is logical since almost all value-added activities are transferred to the future state. When one specific value-added activity arises in two separate places in the current process, for example for two different clients, these activities are only represented

one time in the future state process. In combination with parallel activities and sub-processes in both the current and future state process, a difference in VAT occurs.

For the two best case scenarios, one with four weeks transport time and one with one week, the results between future and current state are nearly the same. The VAT is the same and the total action time and losses differ with only 0.4 hours between the current and future state, for both of the best case scenarios. There is a bigger difference in the total process time, equal to 14.3 hours. The difference is natural since the process is redesigned in the future state. Due to this, in combination with parallel activities, differences occur. Worth mentioning, the total process time could be further reduced if all activities before sending the request template are ignored. This corresponds to nearly 100 hours. Additional reductions could be achieved with lower production time, storage time and further reduced transport time, since all these activities are average values.

Overall, losses and diverse types of waste have been removed by several redesigning strategies. Common improvements with the Makigami tool are faster throughput time, less output errors, less transfer, reduced costs, reduced lead-times, decrease in non-VAT, or increase in job quality. (Makigami Methodology 2021) Theoretically, these are accomplished in the future state process. The Makigami has visualized the process including responsible functions, where they are operating in the process, and respective functions needed information. Commonly for all functions is the lack of knowledge of the process and other functions need, combined with lack of instructions on how to create correct requests.

5.3 Information systems

Based on the result of summarizing the usage of information systems in the current process, it can be concluded that there are many involved information systems. Since all systems are not equally suitable for supporting business distinct processes, several information systems are not necessarily negative (Puschmann and Alt 2005). For a complex and global company several information systems are often necessary to support vital business activities (Kim and Shunk 2003). Changing the setup of the information systems used in the work process is a time-consuming and costly task. However, it is important to ensure that the information systems are used correctly, as this is an enabler for supply chain performance. It strongly relates to information sharing and is central to an efficient supply chain. (Du Toit and Vlok 2014). Therefore, minimizing shortcomings, ensuring optimal use of existing systems through a seamless experience is important (Puschmann and Alt 2005).

5.3.1 Variation in set up of information systems

Due to the different setup of systems used in the process, it is difficult to create a unified work process. Which information system that are used in the daily workflow depends partly on the geographical location of the function. A concrete example is the WMS used. Three different systems within this category have been identified as different systems used by different warehouses. Another illustrative example is that the three production centers are using a set-up

which varies in the level of automation. In Production B there is a higher level of usage of automatic methods through WMS and ERP.

It is beneficial to keep in mind, when adjusting and improving the process, that the differences in the set-up of information systems are a limiting factor. This makes it difficult, for example, to create a standardized process. Further, working towards more of an automatic approach, however, is favorable in many ways. Capabilities such as effective data management and seamless flows are crucial to adapt to technological development and stay competitive on the market (Min et al. 2019). It can be an extensive job to make a process more automated. However, it is beneficial that there is currently a production site that has applied more automated methods with a successful result. In the map presented today, the productions are still separated as a larger, more comprehensive analysis of what the automated process looks like and how it can be applied to other sites is required. However, it can be stated that the more automated method used at Production B can therefore be emulated to create smoother and more synchronized processes.

5.3.2 Lack of knowledge of information systems

Due to different set-ups of information systems, the process of identifying a need for packaging material looks different with varying levels of efficiency. Internal clients requesting packaging material use different strategies for finding the information required to fill in the request templates. In several cases, there is a lack of knowledge about where to find the needed information. Due to this, some clients perform work outside of the systems. Such as in Excel to track orders and historical data. When working outside of the system it leads to duplication of information and more time is spent on non-value-adding activities (Makigami Methodology 2021). This can be counteracted through creating a standardized way of working, as well as clarifying for actors how systems can be applied to simplify daily work processes. One of the main parts of improving the current work process is therefore to enable the functions involved to be less dependent on other parties. Instead, involved functions must be able to find the solution to problems themselves. This can be achieved by providing clarity of the information system's purpose and by ensuring that access to appropriate information is provided. Persson (1995) mentions simplifying systems for actors as a central part in logistics process redesign. This includes simplification of transactions and system consistency in the workflow. This has previously been mentioned in connection with creating training material and providing better conditions for functions to find the right information.

Since communication between functions is essential in this work process, a large proportion of the documents used in the process consist of emails. Several functions express that a time-consuming task is long email conversations. In the current process, email is an important information system as it enables the various functions to receive answers to their questions. This in turn makes the process continue. However, as previously stated, the results show that this is something that increases the complexity of the process and generates large waiting times. It has been specifically identified that email conversations often arise because of inaccuracy in order templates or because clients have a lack of visibility in transport from the factory to their own site. Solving these core

issues in the future state map can hence reduce extensive email conversations that generate work and waiting times for multiple parties.

5.3.3 Inaccuracy in information systems

Another aspect to consider in regard to information systems is that they should contain relevant and accurate information. It has been identified that inventory data in warehouses does not always correlate to reality. This is problematic as inventory is a vital aspect to consider before determining whether a request for material should be made or not. A cause for this has been found to be partly incorrect handling during inbound deliveries. To counteract this, it is important to provide employees with the right information so that they can properly perform inbound deliveries. Ensuring that the information in the system correlates to reality provides greater reliability in the data needed to make operational and strategical decisions.

5.4 Performance measurement

Based on the results of studying the use of performance measurement tools, it can be concluded that there is no general approach for internal testing. Some functions used metrics specifically for internal testing, but most did not have specific metrics linked to the coordination of packaging material for internal testing. However, a majority of participants mentioned that they used performance measurement tools for other purposes. Often for external customers.

5.4.1 Gaps in current performance measurement

The result presented is critical since measuring performance is important, especially for a process that is vital in a company's value offer. The procurement function plays a fundamental role in an organization and can increase competitiveness, influencing an organization's profitability in a positive way (Pereira et al. 2014). Specifically, internal testing at Tetra Pak enables delivery of high-quality solutions to customers and develop new solutions to be competitive in the market. Focusing on the improvement of the procurement process is important as it contributes to the success of the overall corporation (Knudsen 2003).

The fact that focus lies on external procurement further gives misleading signals. An example is the warehouse expresses that KPIs are not currently used specifically for materials. However, for other products that are in stock. Furthermore, it is described that it would be possible to implement if there was a desire for it. Measurements should be applied to all parts of the organization. If not, it may seem that not all parts are of equal importance and there may be reason to question why that part of the organization is even needed.

A collaborative performance system refers to the implementation of the metrics used to measure the process and thereby guides the members of the chain to improve the overall performance (Simatupang and Sridharan 2005). If metrics are not used it makes it difficult for leaders and managers to understand the performance of the team. Something that the manager of TOMS expresses to be a gap today. Interestingly, the Planning leader for the team has KPIs that measure

the performance of this specific process. However, this is not something that is shared with TOMS. Generally, not sharing KPIs is problematic as these acts as a foundation for creating motivation since incentives are made clear (Neely 1999).

A previously identified problem has been the complexity in the current work process. Using performance measurement allows the organization to better understand processes since it can help visualize where improvement is necessary, for example where issues such as bottlenecks and waste arise. Additionally, it can provide data on where performance is satisfactory and hence help the organization to focus on the right areas. (Neely 1999) However, to implement right KPIs, a deep understanding of the process is required.

5.4.2 Suitable performance measurement metrics

In conclusion, Tetra Pak can see great gains in implementing a comprehensive performance measurement system which includes all involved functions in the process of coordination packaging material for internal testing. In literature a gap has been identified regarding how to measure the performance of internal service quality (Brandon-Jones 2017). To analyze how a suitable performance measurement approach should be applied, relevant literature in the area will be combined with the Tetra Pak specific situation.

Generally, KPIs should be measured over time and aim to give an indication of the rate of improvement (Hatry 2006). The focus should be on the overall performance, including all relevant units and aim to develop process-based measurement systems (Naslund and Williamson 2010). To enhance the procurement function´s performance, implementing appropriate measurements of procurement performance is a requirement. The performance of procurement is suggested to start from purchasing efficiency and effectiveness in the procurement function. Further, the metrics should be both financial and non-financial. All core areas and activities of procurement should be included. (Kakwezi and Nyeko 2019) Specifically for internal procurement it is important to include flexibility, training, leadership, information relevance, proactive decision making and communication (Brandon-Jones 2017).

SCOR is a strategic planning tool with the suitable purpose to decrease the complexity of SCM by simplifying it and assisting in decision making (Huan et al. 2004). It builds upon the four areas of processes, performance, people and practices. Three different performance categories, and eight performance attributes are included in this framework.

Table 5-1 below is based on the SCOR model and presents suitable KPIs that are recommended to be applied for the specific process of coordinating packaging material for internal testing. These are based on currently used KPIs at Tetra Pak seen in Table 4-19 in *4.5 Performance measurement*, evaluated quality factors presented in *Table 4-4: Functions involved in the Makigami process map and their corresponding quality factors, as well as how to measure this* in *4.2.1 Basis for Makigami analysis* and relevant literature.

Table 5-1: The performance framework recommended for the process of coordinating packaging material for internal testing.

Performance categories	Performance attributes	KPIs
Resilience	Reliability	Perfect Order Fulfillment (quality, quantity, ETA).
		Import activities.
		Information accuracy (number of intermediate documents).
	Responsiveness	Order Fulfillment Cycle Time (total process time).
		Proactive decision making (forecasting).
		Resolution time (waiting time).
	Agility	Supply Chain Agility (flexibility), availability of materials.
Economic	Cost	Procurement operational costs.
	Profit	Profitability.
	Assets	Inventory management.
Sustainability	Environmental	Materials used.
		Waste generated (scrapping).
	Social	Training.
		Leadership.
		Collaboration.

5.4.3 Implementing performance measurement

One should consider that implementing a full-scale performance measurement tool requires effort. A fundamental of performance measurement is that measures should be aligned with the strategy of the organization. Therefore, measurement should be reviewed regularly to ensure that the alignment is constant, and that the focus lies on what is important. Additionally, it is important that there is support from senior managers to measure this success, where the key is to ensure that it is an activity that is helpful for the organization. It is also important that there is equal support from the employees, as they should understand why the performance measurements are needed and how they can support them in their work and the process of improving. Lastly, the correct performance measurement framework is only valuable if it can be ensured that data will be analyzed and translated into action. Therefore, it is of great importance that the link between measurement and behavioral changes is clear. (Neely 1999)

5.5 Basis for recommendations

To build a foundation for suitable recommendations to provide to the case company Tetra Pak, the analytical tools of the impact effort matrix, as well as the countermeasure ladder have been applied. To balance the factors of impact, effort and efficiency of the recommended solution, it is relevant to consider both tools to obtain an in-depth analysis.

5.5.1 Impact effort matrix

To determine which actions to apply, the impact effort matrix have been used. It is a useful tool in SCM, especially during the improvement phase to give guidance forward (Kowalik 2018). It is therefore used as a basis for the recommendations finally given to Tetra Pak. The founded solutions presented in the future state Makigami, with respective impact and effort, are summarized in Figure 5-1 below.

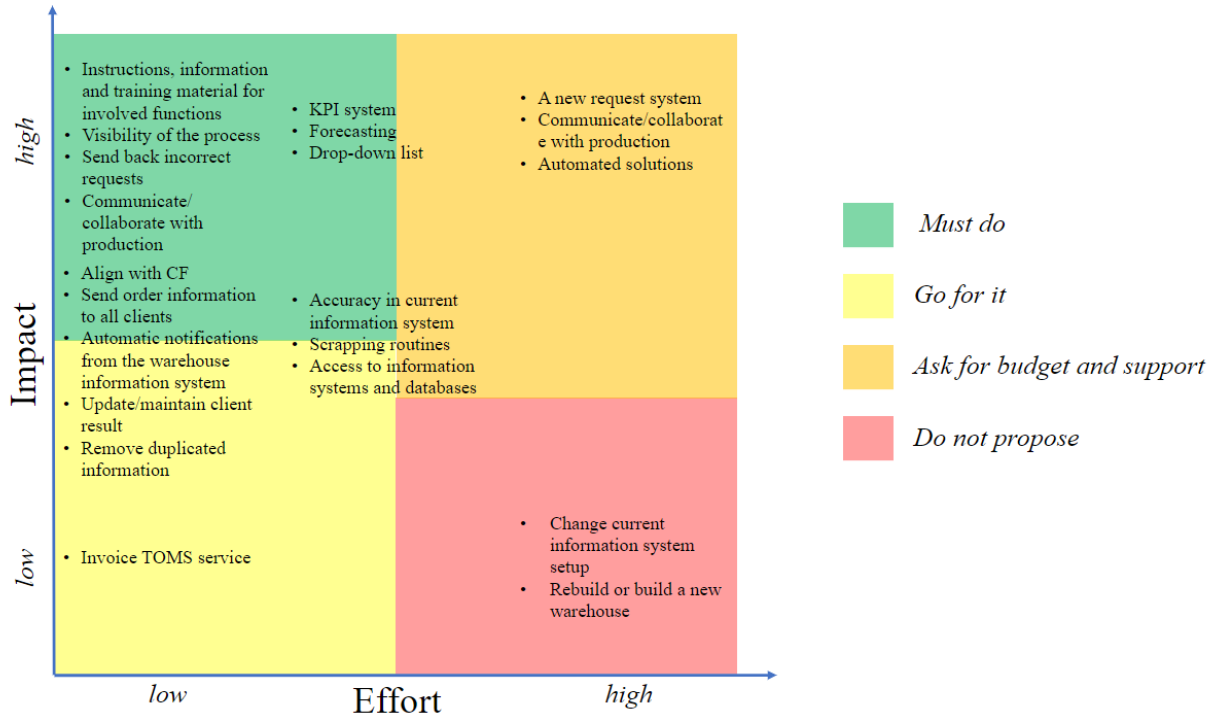

Figure 5-1: Impact and Effort Matrix. (Own illustration)

5.5.2 Countermeasure ladder

The founded solutions presented in the future state Makigami, are further evaluated based on the different levels of the countermeasure ladder. The tool is effective to evaluate recommendations through determining the long-term gains (Makigami Methodology 2021). The recommendations and the correlating levels are presented in Table 5-2 below.

Table 5-2: The solutions evaluated based on the levels of the countermeasure ladder.

Proposal	Level
Instructions, information and training material for involved functions	2
Visibility of the process	3
Send back incorrect requests	1
Communicate/collaborate with production	3
Align with CF	4
Send order information to all clients	4
Automatic notifications from the warehouse information system	6
Update/maintain client result	-
Remove duplicated information	6
Invoice TOMS service	-
KPI system	3
Forecasting	3
Drop-down list	4
Accuracy in current information system	3
Scrapping routines	3
Access to information systems and databases	3
A new request system	5
Communicate/collaborate with production	4
Automated solutions	6
Change current information system setup	6
Rebuild or build new warehouse	6

5.5.3 Recommendations not to propose

From *Figure 5-1: Impact and Effort Matrix*, the solutions in the lower right red corner are not recommended to implement since these have a low impact and require a high effort. Firstly, it requires large investment to change the current setup of information systems (Du Toit and Vlok 2014). Furthermore, it is not granted that an information system change will largely impact the company as this has not been identified as the core issue. However, for the current setup to work effectively, providing support for all new users is key (Brandon-Jones 2017).

To reconstruct the currently used warehouse with the right conditions requires a high effort, once again corresponding to a large investment. The solution used today, to store the material for a period of time before usage, is favorable due to the high investment cost occurring when rebuilding or building a new warehouse. The impact can further be considered low since only a few number of days are removed from the process time, corresponding to a small difference compared to the total process time presented in chapter four, under *4.2.3.2 Lead-times.*

However, based on the countermeasure ladder analysis alone, these mentioned suggestions can be seen as beneficial. Adjusting information system setup can increase automation and reduce manual work, while a reconstructed warehouse would eliminate the operation of cooling down packaging material. However, in combination with the high effort considered and the high cost of the proposals, it is not considered as appropriate recommendations to give at present.

5.5.4 Recommendations to go for and must do

The solutions presented in the middle of *Figure 5-1: Impact and Effort Matrix* are recommended to implement. It is beneficial to improve the accuracy of information in the currently used information system. This is especially true connected to the warehouse's information system, to reduce excess inventory and unnecessary movement (Liker 2020). Persson (1995) suggest that this can be accomplished by improving the information processing, which in turn could be possible by frequent inventory checks. Ensuring that inventory levels are accurate makes it more difficult for functions to make inaccurate decisions, such as ordering wrong quantities of material, resulting in excessive scrapping or material shortage. Therefore, this solution corresponds to level 4 in the countermeasure ladder. (Makigami Methodology 2021) The optimal solution is one where regular inventory checks are not necessary, due to no flaws in the system. However, this is not a realistic solution. Therefore, regular inventory checks are recommended to implement and accomplish. The impact for this recommendation is medium because the process can continue without this redesign, but with greater flaws. Implementing relevant instructions and creating time to accomplish the actual inventory checks can be time consuming. However, Production B already performs regular checks with successful results which strengthens the relevance of the suggestion. This does also explain why the recommendation is placed at medium effort.

Next solution corresponds to a better routine connected to scrapping. Today, the warehouse sends out an email, once a year, where the client is responsible to decide whether the packaging material is to be scrapped or not. There are currently shortcomings in this routine as it has been shown that the warehouses stock materials that are well past their expiration date. It is recommended that the client should take more responsibility, be aware when packaging material has expired and inform the warehouse when this occurs. This requirement should be effectively communicated, but it should be noted that this does not necessarily ensures that the action will be taken. Therefore, it receives only level 2 in countermeasure ladder as it is likely double checking will be required to ensure balanced inventory (Makigami Methodology 2021). However, it requires a medium effort for the client and will have a medium impact for the organization, where the storage space will be better utilized (Liker 2020). Hence it is still relevant to recommend.

The last solution with medium impact and effort is to give functions concerned access to relevant information. Providing access increase visibility and this solution includes giving the client access to the tracking system today used by Supply chain control tower, and give concerned functions access to databases, invoice documentations and order confirmations. Additional solutions are sending out automatic notifications of status updates. All this information is expressed by clients to be lacking in the current work process. Having access to this information will facilitate the

process by removing several communications loops when information is missing and by removing duplicated work (Liker 2020; Makigami Methodology 2021). Warehouse notifications are easy to implement as the system already contain this function. It has a medium impact since the process can continue without the notifications. However, this is an effective countermeasure to decrease unnecessary operations, but it does not eliminate the risk of them occurring. However, providing information that is expressed to be valuable for the function, such as visibility during shipment for the requestor, increases the chance of it being used. The actions are further important to reassure all clients have access to the right information (Makigami Methodology 2021).

Further connected to visibility is creating deeper understanding of the process. This concerns function's roles, needs and responsibilities which are not made clear for involved actors today. Visibility is a vital part within supply chain integration thus it generates a great impact (Stone 2004). Consequently, it requires a low effort with this study's provided knowledge and process map. The work of creating an understanding of the process, on the other hand, is something that should be done over time where the results of this work are a good basis. Therefore, it is recommended to continue to update the process flow, including the client result, in order to keep track of all concerned functions and their needs.

Another recommendation requiring low effort is TOMS invoicing their service. This is something that has been done before, indicating a low effort during implementation. However, it will increase the amount of administrative work. Further, TOMS have a vital role in the process of coordinating packaging material, likewise other involved functions invoicing their service today. Based on the countermeasure ladder it cannot be evaluated based on improving steps in the process. It does not necessarily affect the process's flow and can therefore relate to low impact. However, by invoicing the service, it signals to the other functions that the service is of significant value. Several clients have expressed that a common method for problem-solving is contacting TOMS. At present, TOMS are vital for the process to proceed and for material to arrive on time, in full. Thus, they hold a central part in the progress of the process and should be valued in accordance.

Furthermore, for special test requirements, communication with the CF is important to ensure that the packaging material ordered is as desired. This is easy to accomplish through clear communication while the impact is high due to the consequences that can arise if the wrong packaging material is produced. Further, aligning with CF is an effective countermeasure as it makes it more difficult to perform incorrectly and decrease the number of errors.

5.5.3 Recommendations to ask for budget and support for

The recommended solutions with high impact and effort, presented in orange color in *Figure 5-1: Impact and Effort Matrix*, should be implemented over time. The automated solutions today used by Production B have great advantages since it eliminate manual work and provide high accuracy in the process. Automated solutions in the current work process, such as automatic PR creation done in Production B, would therefore facilitate the process. It has a high impact but requires a high effort where the implemented automated solutions require maintenance even after being

implemented (Brandon-Jones 2017). According to countermeasure ladder, this solution achieves a high level, which more clearly demonstrates that it is an effective method to improve the process (Makigami Methodology 2021).

It has been noted that there are problems connected to incorrect requests, especially for the clients but also throughout the entire process. One solution to this problem would be to implement or update the information system for requests as the risk of proceeding without a correct request is minimized. It eliminates manual work hence receive a high level in the countermeasure ladder. This would have a significant impact, resulting in a reduced number of communication loops arising due to loss of information in all stages (Makigami Methodology 2021). However, implementing or updating an information system requires a significant effort with a large investment (Du Toit and Vlok 2014). Another short-term solution to this problem could therefore be to send back incorrect requests. This would still have a high impact on the process but only require low effort. The requester would be given an opportunity to learn how to create correct requests and minimize the workload for the team of procurement coordinators. However, this receives only level 1 in countermeasure ladder as the solution includes reminding the person to correct wrongdoings (Makigami Methodology 2021).

Another solution connected to incorrect request is to provide training material and instructions for the functions concerned to solve the core issue. For example, the process of requesting material through templates are today done in an inconsistent way due to lack of knowledge. This should be addressed by providing the right knowledge to clients on how to place a correct order and thus achieve a more consistent and seamless process. It should be noted that instructions and training material does not eliminate errors and therefore some double checks may still be required by the procurement team. It is therefore important to ensure training materials are effectively used through education. However, long term improvement as mentioned above which includes upgrading the existing system decrease the human element through automation and is favorable to adapt according to the countermeasure ladder.

Furthermore, one recommended solution is to increase communication and collaboration between the clients, especially with production (Persson 1995). One solution for this could be to have one warehouse system for all sites, or one common warehouse, where all clients can see the stock levels. This would have a high impact but require a high effort since a new system would generate excessive costs and is therefore not relevant at present. However, another more appropriate solution would be to increase communication between the clients by implementing an activity in the process where the client asks if there is packaging material available. This communication between parties in need of similar materials means that stock levels have greater potential to be balanced resulting in less scrapping and in some cases reducing transportation (Makigami Methodology 2021). A common problem in the process that causes scrapping is the MOQ since it is common that clients must request quantities larger than needed. Through creating a collaboration where other actors can utilize leftover material, a better balance can be created. This collaboration further requires low effort as it is something that is already performed between Production B and several clients with more balanced inventories and less scrapping as a result.

Between the green and orange colors in *Figure 5-1: Impact and Effort Matrix*, it is recommended to implement a comprehensive KPI system, forecasting and creating a drop-down list for existing variation of information. These alternatives all have a high impact on the process. A KPI system would facilitate the possibility to measure the process and hence evaluate and improve the process. However, it does not aggravate the risk of making mistakes in the process or increase automation. Instead, it gives a better overview and understanding whether the process is carried out correctly or not, hence it receives level 3 in the ladder. Forecasting would facilitate the planning of CF and the availability of packaging material for internal testing. It does not necessarily eliminate wrongdoings but minimizes potential risks, hence it receives level 3 in the ladder. A drop-down list would make it easy to find correct information, today hard to find, and reduce the risk of incorrect proceeding of information. (Persson 1995) Therefore it is positioned at level 4 as it makes it difficult to proceed if information is incorrect (Makigami Methodology 2021). All three solutions require a medium effort since KPI's are already used for other parts of the organization today, likewise, forecasting which is also an ongoing process. The drop-down list however does require someone to gather the right information but also maintain the information in the system.

5.6 Discussion

The focus in recommendations is solutions giving a high impact and simultaneously requiring low effort. When considering the countermeasure ladder, several suggested solutions are not receiving the most desired level, resulting in less human elements and automation. The solutions that achieve this high level, on the other hand, are those that often require great effort and thus also great costs. From this aspect, it has been relevant to weigh both of the tools to obtain an in-depth analysis with relevance. For this complex process, the suggested solutions can in combination generate a great impact if successfully implemented. The potential of the suggested future state is not least demonstrated through the reduction in the number of actions and transfers that can be achieved.

To correctly interpret the results, there must be a broad understanding of the subject area. The in-depth literature search was therefore a key factor in interpreting the results correctly. Either way it should also be considered that since the main data collection is based on interviews, there is a wide margin for interpretation. Furthermore, the number of interviews conducted is limited. If more interviews had been conducted, there is reason to believe that the results may vary. However, it should be considered that what is shared in the interviews overlaps and statements reinforce each other. This was a crucial factor in finally creating a cohesive map, where all perspective is woven in to form one holistic process.

This study is limited by the fact that the focus is on communicating recommendations, rather than implementing them. Future development opportunities for the company are therefore mainly to act to implement the recommendations presented. In addition to this, the company is then also given the opportunity to test the theory to see if it is possible in practice. Solutions have been presented with regard to how likely it is that it can be implemented at present, thus weighing in aspects such as effort, impact, basic conditions and company standards. However, it is beneficial to further investigate possibilities to ensure the best possible results. In addition, the phase of implementation

is a significant factor affecting the outcome of the improvement work. Due to this, it would have been beneficial to assist and provide profound recommendations in this area as well.

However, as a result of this study, a foundation will be provided for Tetra Pak to move forward in improvement work within the investigated phenomenon. It can be concluded from the analysis that there are conclusions that can be drawn which are general. Therefore, the study can also contribute to external actors. The identified patterns in the existing process are often general and concern topics such as collaboration, lack of knowledge and high complexity. Further, the foundation for the analysis is based on literature in the field. Although problems in some cases arise in a specific part of Tetra Pak's work process, the core issue is something that has been identified through the literature search as general aspects within SCM. Due to this result, the study can be considered relevant for several actors, and not just the case company.

Except for conclusion building upon theory, it also develops previous knowledge in the field. Something that has been identified as a deficiency in the area is that it can be difficult for practitioners to navigate and find a method that is concrete and easy to apply. A major reason why this study is further useful for many is that the method is applicable on a general level. It is a method that provides a broad perspective and a basis for mapping and improving any work process.

6. Recommendations and conclusion

This chapter provides the appropriate recommendations for the case company based on the analysis of the results. The recommendations and conclusions connected to each research question are first elaborated on. Thereafter, the contribution of this study is presented as well as limitations and future research.

The purpose of this thesis was to improve the coordination of packaging material for internal testing at Tetra Pak. To accomplish this, this study was based on a single case study where the coordination of packaging material for internal testing was the unit of analysis. The project had a predominant focus on a deductive approach since existing theory was reviewed to investigate the area of study. Qualitative and quantitative data was collected to then be structured and analyzed to fully investigate the phenomenon. The main tool used to do this was Makigami analysis.

6.1 Research questions

The purpose is carried out by answering the three selected research questions. The answers to these are described in the sections below.

6.1.1 The current process of coordinating packaging material for internal testing

At Tetra Pak, there is a need to ensure that the flow of packaging material for internal testing works efficiently. To accomplish this, there is a desire to gain a deepened understanding of the current flow, with TOMS as a connecting function. The Makigami has visualized the process including responsible functions, where they are operating in the process, and respective functions needs. The current process of coordinating packaging material for internal testing is presented in detail in the current state Makigami, found in Appendix F. The function TOMS has an important and necessary role in the process for coordinating packaging material for internal testing. With almost more than double transactions and actions compared to all other functions in the process, basically all information goes through this function. With TOMS services minded working style, the function is very well appreciated by all the clients.

The basis for Makigami analysis shows that the process includes 14 different functions, with various quality factors and needs. When further analyzing the historical order data, the involved clients, including respective purpose of order, number of involved CF and type of order was clarified. There are several clients, belonging to different departments, ordering packaging material through TOMS for different purposes. These purposes are mainly for different types of project testing, to ensure the right quality before delivering to customers, training courses, solving service issues and for a sample shop. It was noted that for 20% of the orders, a new design is required.

The current Makigami map consists of many activities between several functions with different sub-processes. This creates a need for a vast number of transfers, actions and documents. For some cases this is due to shortcomings in collaboration, a lack of training materials throughout the process and lack of understanding between the functions involved and their individual work process. This creates a large amount of communication loops due to missing information. Furthermore, the process is complex with many exceptional cases and where the outcome varies depending on the situation. This is one reason behind the difficulty for functions within the process to plan. It can be concluded that the total process time is long, but especially inconsistent. This means that clients today need to order well in advance to ensure delivery at the right time.

Today, two different formats of templates are used when requesting packaging material, one new and one old version. If a template is not used, an email is sent containing an already existing PR and other necessary additional information. This is used only by Production B. An identified pattern among sent templates is that several do not include all required information, creating additional communication loops further on in the process. One reason for this is that there is no standard process for clients to follow.

When conducting interviews and performing observations, all identified information systems used by the functions involved in the coordination of packaging material for internal testing were noted. It can be concluded that there are a number of information systems used in the process of coordinating packaging material for internal testing. The setup of systems used in the daily workflow depends on the geographical location.

Before starting to redesign the current process, seven basic conditions and standards were clarified. These are the following: all functions must be included, SAP is the used ERP globally at Tetra Pak, consider environment and cost when selecting transport method, expiration of packaging material, approval of costs, consider regulations and follow the high-level process at Tetra Pak.

6.1.2 Recommended activities for increased efficiency of the process

Based on the current state Makigami, a number of improvement areas have been identified. Several problems and losses were analyzed to find countermeasures. Based on this, a future state Makigami was created. It is concluded that several improvements could be possible by redesigning the process. The future state process includes 100 less transfers, 61 less actions and 94 less documents. This in turn results in an improved total process time, reduced by almost 20% from the current process. The total action time and losses have also been reduced by around 20 hours each.

Overall, losses and diverse types of waste have been removed by several redesigning strategies. Common improvements with the Makigami tool are faster throughput time, less output errors, less transfer, reduced costs, reduced lead-times, decrease in non-VAT, or increase in job quality. Theoretically, these are accomplished in the future state process.

With several solutions and redesigning proposals presented in the future state Makigami, the impact effort matrix was used as the basis for the recommendations. With the help of the matrix,

it is recommended to start with the changes that have high impact but require low effort. These solutions are the following:

- Implement instructions and training material.
- Increase the visibility of the process with the function's roles, needs and responsibilities through sharing process map.
- Send back incorrect requests while simultaneously giving the client the right circumstances to fill in a complete template through instructions.
- Increase communication between the clients by implementing an activity in the process where the client checks if there is packaging material available before ordering new from CF.
- Implementing an activity in the process where the client communication with the CF to ensure that the packaging material ordered is as desired.

When the previously mentioned changes are accomplished, the next focus should be on the redesigning solution that has a medium impact but still low effort. Here are the solutions with medium impact and effort possible to implement:

- Send out order information to all clients.
- Make sure the warehouse's information system sends out automatic notifications.
- Continuing to update the client result.
- Remove duplicated information.
- Improve the accuracy of information in the currently used information system, for example through regular inventory checks and training material for inbound deliveries.
- Implement a better routine connected to scrapping.
- Give functions concerned access to relevant information. Includes giving the client access to the tracking system and give concerned functions access to databases, invoice documentations and order confirmations.
- Re-open the invoice for TOMS service.

Next phase of redesigning should focus on the solution with high impact and medium effort. These solutions could take some more time to implement since they could require a larger budget and support:

- Implement a comprehensive KPI system.
- Implement forecasting.
- Creating a drop-down list for existing variation of information.

The last recommended solutions are the solutions with high impact and high effort. These solutions should be implemented over time:

- Implement automated solutions on several sites.
- Implement, or update, one information system for requests where the risk of proceeding without a correct request is minimal.

6.1.3 Recommended performance measurements for the process

There is a desire to determine how a potentially improved process can be maintained through using appropriate performance measurements. Through this study it has been identified that the performance of the process linked to the coordination of packaging material for testing is often not measured today. However, most participants mentioned using performance measurement tools for other purposes. Often for commercial reasons and external customers.

The result presented is critical since measuring performance is important, especially for a process that is vital in a company's value offer. Further, focusing on the improvement of the procurement process is important as it contributes to the success of the overall corporation. Using performance measurement allows the organization to better understand processes since it can help visualize where improvement is necessary, for example where issues such as bottlenecks and waste arise. Additionally, it can provide data on where performance is satisfactory and hence help the organization to focus on the right areas. The fact that focus lies on external procurement further gives misleading signals. Measurements should be applied to all parts of the organization. Lastly, using metrics is a key factor for managers and leaders to measure the performance of the process and understand the performance of the team.

In conclusion, Tetra Pak can see great gains in implementing a comprehensive performance measurement system which includes all involved functions in the process of coordination packaging material for internal testing. In literature, a gap has been identified regarding how to measure the performance of internal service quality which this study has been aiming to counteract. A guidance for a KPI framework applicable on the specific work process in study is therefore provided.

The framework for performance measurement has been developed to guide the work forward and provide a recommendation on how you should and can measure your performance. However, implementing metrics requires effort to generate a significant impact. To ensure that the put in effort generates the desired results, insights are also shared regarding what you should consider when implementing this. Some performance measurement fundamentals are that measures should be aligned with the organization's strategy and that managers and employees support them to measure success. Lastly, the correct performance measurement framework is only valuable if it can be ensured that data will be analyzed and translated into action. Therefore, it is important that the link between measurement and behavioral changes is clear.

6.2 Contribution

This study contributes to the case company, to academia and to the authors themself. Firstly, the master thesis provides guidance in improving the coordination of packaging material for internal testing at Tetra Pak by investigating the current process, identifying gaps and providing the case company with recommendations for sustainable improvements. The result helps improve the

coordination of packaging material by reducing unnecessary handling time and processing and thereby also reducing unnecessary costs and environmental impacts.

In the area of SCM, there is broad knowledge regarding how processes can be optimized to be more efficient, which is applied to provide relevant and academically supported recommendations to the case specific company. However, based on current research, there are identified gaps in literature. There are gaps in empirical evidence of actual benefits arising from SCM and it can be difficult for practitioners to navigate within the concept of SCM and find applicable and concrete frameworks for one's specific business. Especially, the internal processes, which are in scope of this study, are not emphasized in literature today. This study counteracts these identified gaps through bringing clarification for the company, as well as practitioners on a general level. This clarification includes how to use SCM to improve a process, emphasizing the internal perspective. As a result of this work, a concrete approach has been successfully presented that can be directly applied to Tetra Pak as a company. In addition, it is also an approach that can be applied to other organizations that have a goal such as improving their work process.

Lastly, the thesis contributes to the authors themselves by their increasing knowledge regarding the field studied and how to manage and solve complex problems. These learnings will be useful in future projects in the industry.

6.3 Limitations and future research

When examining a process, a complete and holistic analysis of the phenomenon is desired. This study is partly limited as the focus lies on only the main parts involved in the process of coordination packaging material for internal testing. What is excluded, which could be relevant to investigate to grasp the whole picture, is procurement of raw material to produce packaging material, the actual testing, and the need for other additional components necessary to perform testing.

Another limitation, additional participants in the data collection phase would be beneficial to receive an even more comprehensive approach. All relevant stakeholders are involved in this study to retrieve a broad perspective. Due to the high number of functions involved and high number of belonging employees, only a few representatives were selected from each function. Even though every selected representative was carefully chosen regarding how strong the connection was to the process in study, more perspectives would generate more of a holistic view. Furthermore, it would have been possible to build on the study by using other methods as a complement to interviews, such as questionnaires or additional observations.

Beyond the limitations mentioned, the timeframe is also a limiting factor to keep in mind. This was a reason to why the Makigami analysis was limited to presenting improvement proposals, but excluded implementation. Future development opportunities for the company are therefore mainly to test the theory and act to implement the recommendations presented. Especially, it would have been beneficial to assist and provide profound recommendations for the company in this area as well.

This study has contributed on a general level as it provides an approach that can be applied to other businesses. However, it can be added that this study and the method presented are not comprehensive in the field of SCM. The area is complex and consists of many different theoretical frameworks that are not touched upon in this study. A company's specific process is therefore not necessarily advantageous to be examined based on this method. Further research should therefore aim to further minimize gaps by providing clarity and helping companies navigate within the field. Especially, through giving guidance in how they can concretely and effectively improve essential business processes.

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Appendix

Appendix A: Case study protocol

Table A-1: The case study protocol.

Section	Contents	Purpose
Case study design	-Single case -Unit of analysis: functions included within the Tetra Pak supply chain that affect the flow of packaging material for internal testing. -The improved setup for the coordination of packaging material will be determined by answering the following questions: • How does the current process of coordinating packaging material for internal testing look like? • How could the efficiency of the coordination of packaging material be increased? • How can the performance of the coordination of packaging material be measured?	This step helps the research in guidance throughout the project. It focuses effort so that the processes are aligned with the purpose and the research questions connected to it.
Preparing for data collection	-General training: interviewing techniques, determining how to perform literature search and investigating theory of case study research, including potential limitations. -Development of CSP to provide guidance. -Identify data to be collected, both primary and secondary data.	Training helps the researcher to be prepared for the crucial data collection and performing the case study.
Collecting evidence	-Data collection plan: multiple data collection methods, both qualitative and quantitative. Based on Yins (2014) six sources of evidence, Interviews, direct observations, literature and internal documents are used. -Relevant people to interview are selected and planned, see Appendix B. -Observations on the plant to better grasp the workflow of people working with the coordination -Data will be stored in documents and audio recordings at Tetra Pak servers for confidentiality reasons.	Basing the collection method on the research questions to ensure that the information gathered is adapted to achieve the purpose of the study. Ensure a structured approach during data collection. Triangulation strengthens the grounding of theory.

Analyzing evidence	-Determine appropriate analysis strategy: explanation building. -Gathered data will be illustrated with the Makigami tool to investigate the efficiency of the processes. -Keep in mind the three principles: attending to all the evidence, presenting evidence separately from interpretations, exploring alternative interpretations.	Ensure that the analysis is in-depth and considers all relevant aspects.
Reporting	-Audience for the report: supervisors, Tetra Pak workers, students, other developers or scientists who are interested in areas covered in your dissertation. -Determine the optimal structure. -Have report reviewed. -Write simultaneously throughout the process.	Layout of the report which ensures that it is aimed at the right audience and follows an appropriate structure.

Appendix B: Interview plan

Table B-1: Interview sessions for TOMS.

Position	Date
Procurement coordinator one	15/2-2023 10:30-11:30
Procurement coordinator two	15/2-2023 9.00-10.00

Table B-2: Interview sessions for Collaboration.

Collaborator	Position of interviewee	Date
TPI	TPI Customer Service Coordinator – Business Expert	6/3-2023 14.15-15.30
Warehouse Malmö	Warehouse coordinator	5/4-2023 10.00-11.00
MDM	Master data expert	15.00-16.15 20/3-2023
Design HUB	Packaging graphics expert	1/3-2023 10.00-11.00
Coding and specifications	Specification system owner	9/3-2023 14:30-15:30
CF A	Senior Operational Planner	9/3-2023 13.30-14.30
CF B	Planning and logistics manager	16/03-2023 12.00-13.00
	Operational planner	
CF C	Senior Operational Planner	10/3-2023 11.00-12.00
Material and capacity planners	Capacity Team Led	24/3-2023 10.00-11.00
Custom clearance	Supply coordinator	6/4-2023 9.00-10.00
Warehouse Lund	Warehouse operator	8/3-2023 10:00-12.00
	Warehouse and forklift leader	
Supply chain control tower	Outbound Logistic Coordinator	22/3-2023 14.00-14.30

Table B-3: Interview sessions for leaders and managers.

Position	Date
Planning and logistic manager	28/2-2023 13:00-14:30
Planning leader	28/2-2023 10:30-12:00

Table B-4: Interview sessions for clients.

Client	Position of interviewee	Date
Client F	Service Administrator	14/3-2023 13.00-14.00
D&T	Development engineer	1/3-2023 13.00-14.00
	Test hall equipment supervisor	23/3-2023 13.00-14.00
	Development engineer printing	24/3-2023 13.00-14.00
	Senior Technical Supplier Manager	30/3-2023 9.00-10.00
D&T	Development engineer	23/2-2023 13:00-14:00
	Development engineer	16/3-2023 13.00-14.00
Client E	Purchaser	20/03-2023 9.00-10.00
Production A	Production engineer	22/2-2023 13:00-14:00
Production B	Supply coordinator	23/2-2023 9:00-10:00
Production C	Master scheduler	21/3-2023 7.30-8.30

Appendix C: Interview guide

Table C-1: Contact information to the interviewers.

Madeleine Karlsson Email: madeleine.karlsson@tetrapak.com	Jennie Jönsson Email: jennie.jonsson@tetrapak.com

Introduction

We are two Swedish Mechanical engineering students from Lund University who are doing our master thesis study within Engineering Logistics. More precisely, we will do a case study at Tetra Pak with focus on the coordination of packaging material availability for internal testing.

Background to the project

We are investigating the coordination of packaging material availability for internal testing. With our research, we aim to understand what parts of the current coordination of packaging material for internal testing are resulting in waste and how the efficiency of the coordination of packaging material can be increased. With a literature review together with a case study, the desire is to map the coordination of packaging materials in order to evaluate all the major processes and to identify improvement opportunities. For Tetra Pak specifically, this can help drive down costs by avoiding delays and errors, and improving cycle time, traceability, collaboration and information availability.

Information on how the data will be shared and reported

Before the interview, a summarized version of an interview script will be shared with the interviewee. The concluded recommendations from the research will be shared with the employees at Tetra Pak through a report and a supplementary presentation in June.

Agreement on confidentiality, privacy and other ethical aspects

Before participating in the interview, we ask for consent to collect data through interviews and audio recordings. All interviews will be anonymous. However, in order to track the process flow, the position of the interviewee will be noted. Privacy and confidentiality will be ensured where only the researchers will have access to any data collected during interviews.

Interview script

Date:

Interviewer:

Co-interviewer:

Respondent:

Location:

Background information

- What is your position at Tetra Pak?
- Shortly describe your role and responsibilities.
- Describe shortly your background within the company.

Daily workflow

- What are the main daily work tasks? (Connected to coordination of packaging material for testing)
- Specific question relating to the function...

Lead times

- What are the allowed lead times to execute your work tasks? (For all mentioned work steps above)
- According to you, what are the most inefficient work steps, in regards to time?

Information systems

- What information systems do you use to execute your daily work tasks? (SAP, excel, paper etc.)
- What information systems do you use to communicate with different functions?

Information sharing and collaboration

- Which functions/people do you connect with to execute your work tasks?
- What information must you rely on to do your job?

- How do you find that the other stakeholders within the network are delivering compared to your expectations?
- Do you experience any knowledge/information losses? (information you wish to have that could facilitate your work)
- Ideally, how would you like information sharing/collaboration to be done in the network?

Challenges

- Based on your role, what would you say are the major challenges associated with coordination of packaging material for internal testing?
- When problems occur, how are these solved?
- How are problems documented/shared?

Performance measurement

- Do you use any performance measurement tools/KPIs to evaluate the flow of material for internal testing? If so, what is measured?
- Is there any follow-up on how well you work against planned daily goals?

Other

- Do you have any general suggestions of improvements?
- Is there something else you want to share with us?
- Do you know anyone else you think we should talk to?

Appendix D: Email to clients

Hi!

We are two engineering students from Lund University who are writing our master thesis at Tetra Pak. More specifically, we are studying the coordination of packaging materials for internal testing. To do this, we have mapped who places orders for packaging material through TOMS (previously called ISM), a team of procurement coordinator one and two. We have found your name since you have ordered at least once in the last five years. We would appreciate it if you could get back to us with answers to the questions below to help us in our work.

- For what purpose do you (or did you) order materials via TOMS?
- Under which department do you order packaging material? (The following nine departments exists: Market Operations, Packaging Solutions, Processing Solutions & Equipment, Services, D&T, Sustainability & Communications, Human Resources & Transformation, Finance & Supplier Management, Legal Affairs)
- How do you identify a new need for packaging materials?
- When you send a request for material to TOMS, is it done in a template?
- What information do you include in your request and where can you find this information?
- Do you have any communication with the CF? If so, when and about what?

Thank you in advance!

Best regards,

Madeleine and Jennie

Appendix E: Purpose of order though the function TOMS

Table E-1: The clients that order PackMat through the function TOMS, including the client's department, and the purpose of the orders.

Department	Client	Purpose of order
Packaging Solutions	Client A	Orders for project testing.
	Client B	Orders for the development of Tetra Recart.
	Client C	Orders for project testing.
		Only design request.
Processing Solutions & Equipment	Production A	Orders for testing filling machines.
	Production B	
	Production C	
	Client D	Orders for the production PDC. Customers around the world can develop new solutions – tested by PDC.
	Client E	Orders for testing renovated buy-backed Tetra Pack machines.
Services	Client F	Orders for training courses on different machines.
D&T	D&T A	Orders for project testing.
	D&T B	
	D&T C	
	D&T D	
	D&T E	
	D&T F	
Finance & Supplier Management	Client G	Orders for project testing.

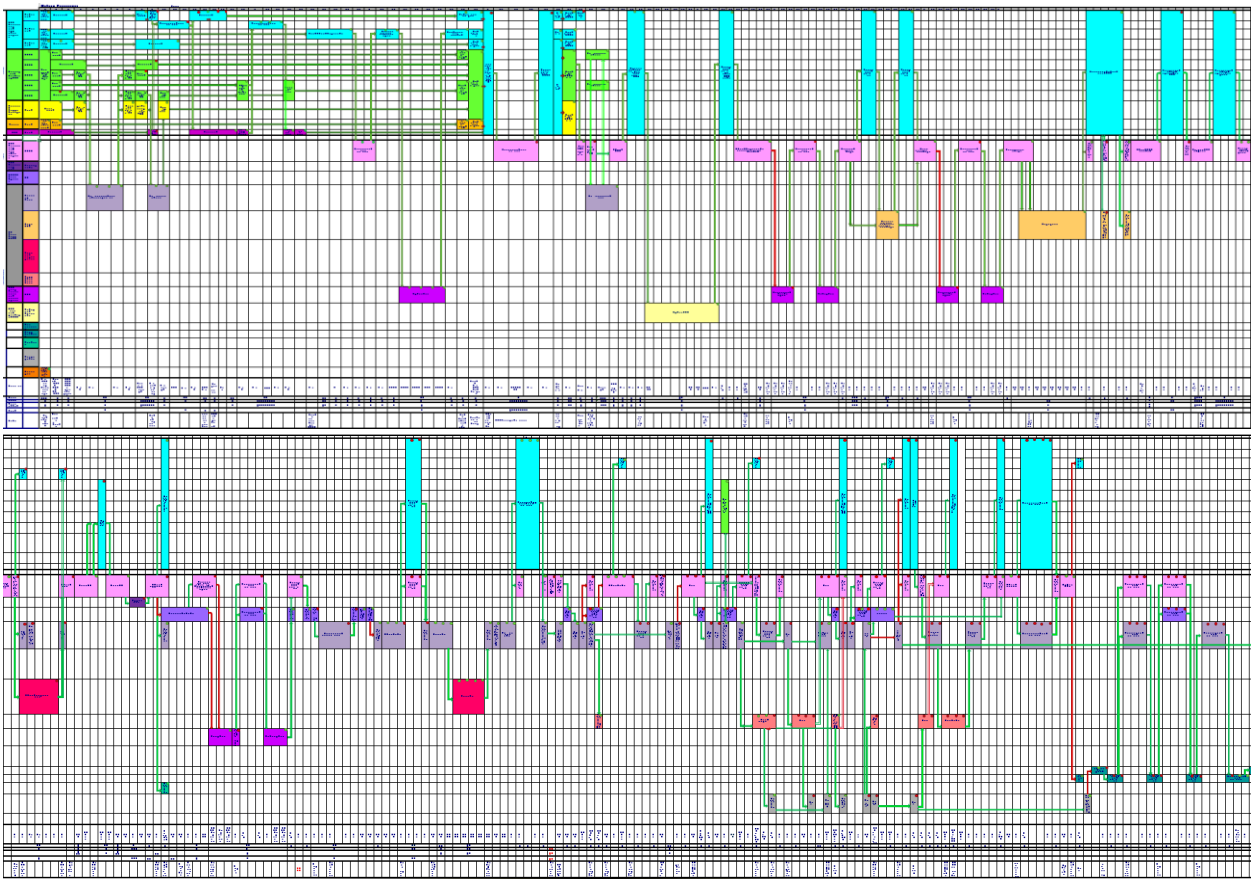
Table E-2: The clients that order AddMat through the function TOMS, including the client's department, and the purpose of the orders.

Department	Client	Purpose of order
Market Operations	Client H	For sample shop.
Packaging Solutions	Client A	Orders for project testing.
Processing Solutions & Equipment	Production A	Orders for testing filling machines.
	Production B	
	Production C	
	Client E	Orders for testing renovated buy-backed Tetra Pack machines.
Services	Client F	Orders for training courses on different machines.
D&T	D&T A	Orders for project testing.
	D&T B	
	D&T C	
	D&T D	
	D&T E	
	D&T F	
Finance & Supplier Management	Client G	Orders for project testing.

Table E-3: The clients that order Design Request through the function TOMS, including the client's department, and the purpose of the orders.

Department	Client	Purpose of order
Market Operations	Client H	Need for new design within a project.
	Client I	
	Client J	
Packaging Solutions	Client B	Need for new design within the development of Tetra Recart.
	Client C	Need for new design within a project.
Processing Solutions & Equipment	Production B	Need for new design within the process of testing filling machines.
	Production C	
D&T	D&T C	Need for new design within a project.
	D&T D	
	D&T E	
	D&T F	

Appendix F: Current state Makigami



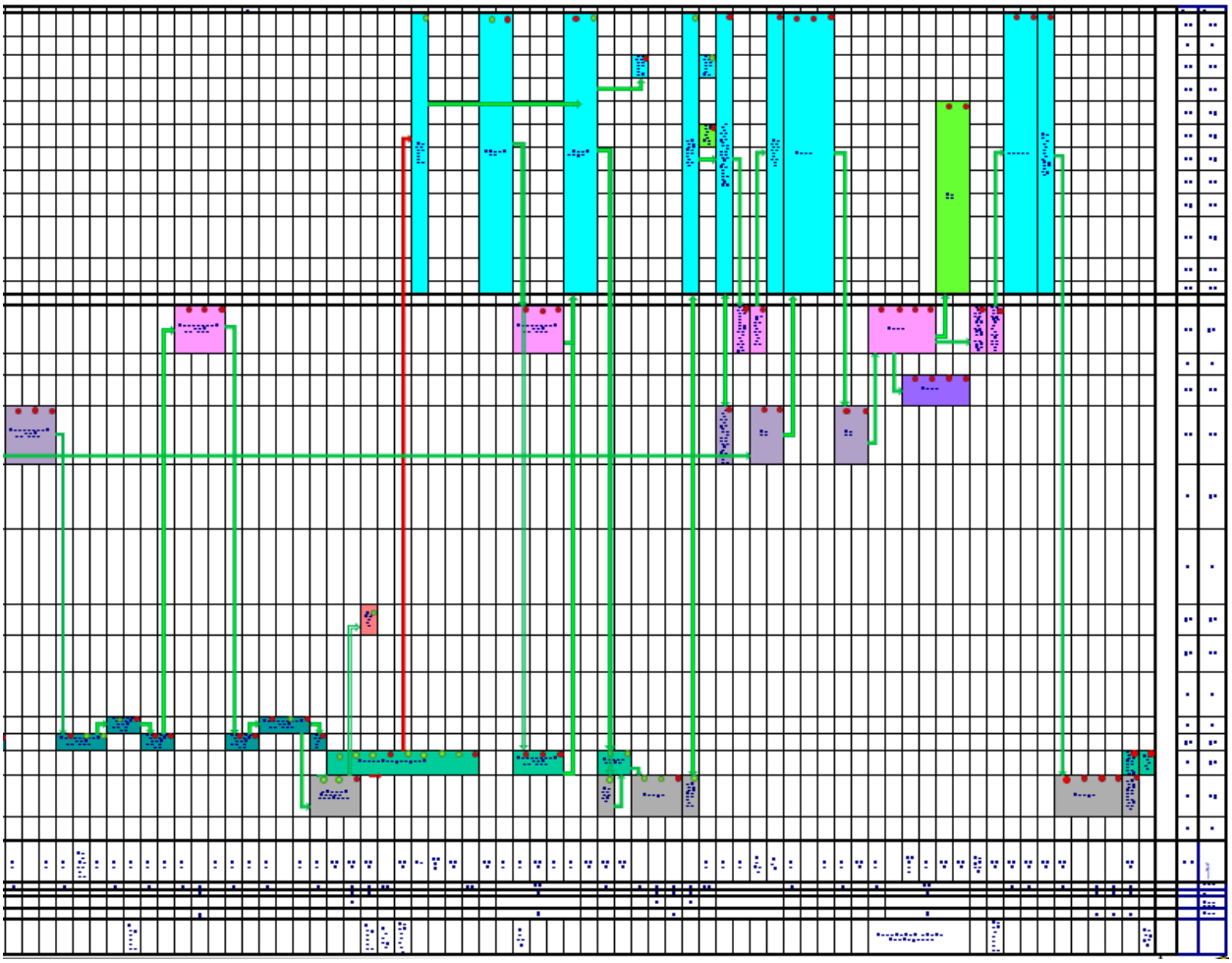
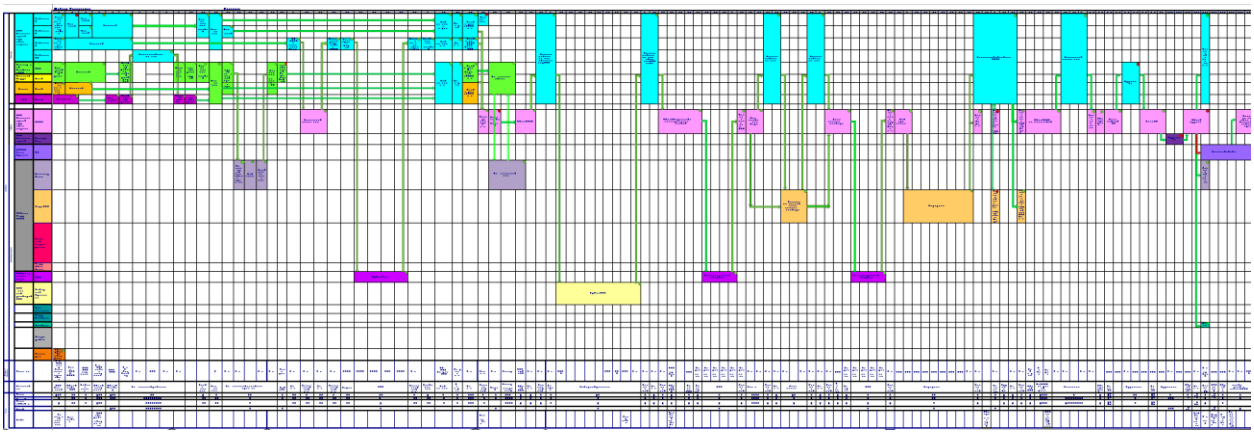
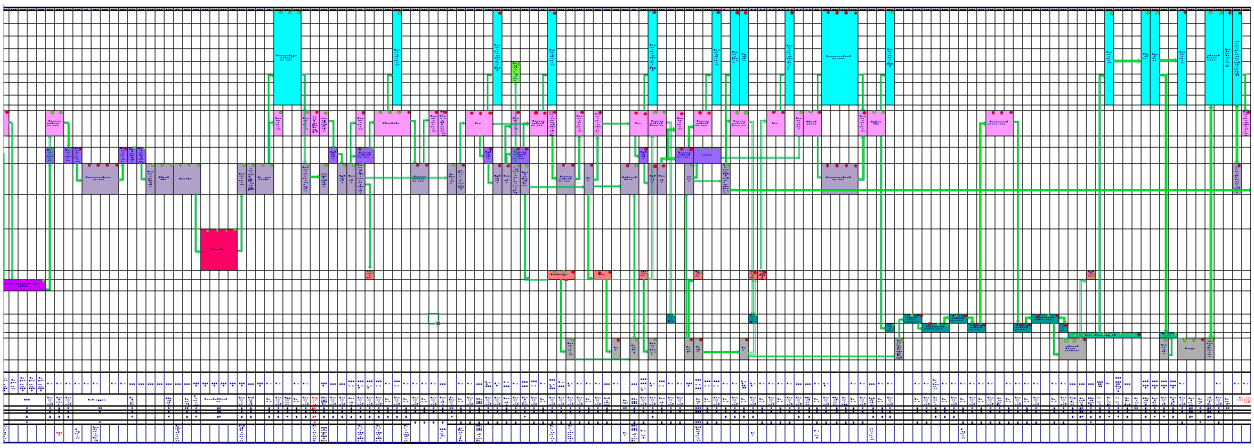


Figure F-1: Out zoomed version of the current state Makigami. (Own illustration)

Appendix G: Future state Makigami





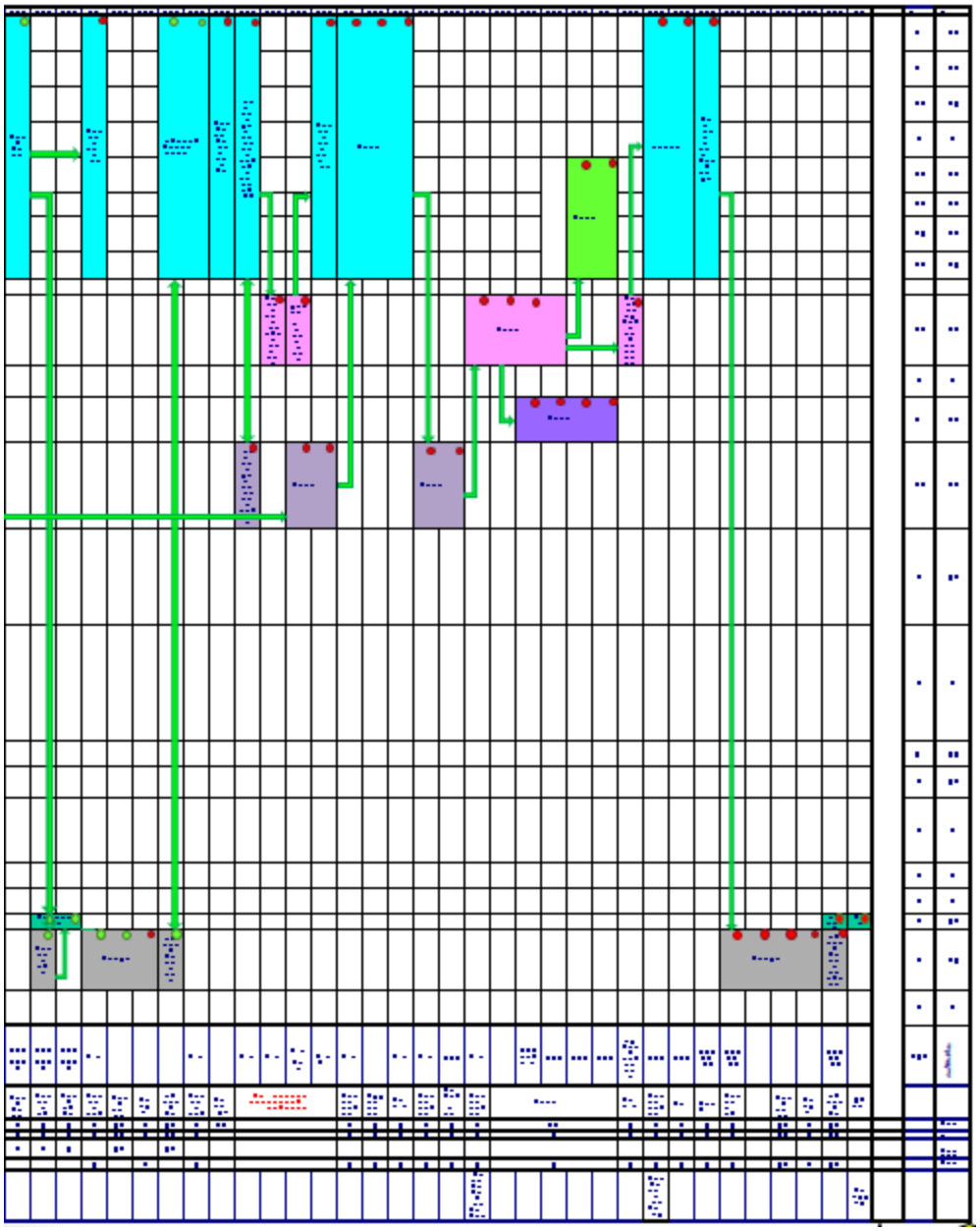


Figure G-1: Out zoomed version of the future state Makigami. (Own illustration)

Appendix H: Information systems

Table H-1: Information systems used in the process of coordinating packaging material for internal testing, including the corresponding purpose and stakeholder using it.

Information system	Purpose	Stakeholder
ERP	See order information.	All
	Make order.	TOMS
	Approve cost.	Client, Planning leader
	See order status.	Factory, Material and capacity planners
	Planning of production at factories.	Factory
	Create invoice.	Factory
	Find material code.	Client
Business intelligence	Contains factory information.	Client, TOMS
	Issue request about material code.	Client
	Receive request required update.	Coding and specifications
WMS	See stock, book delivery.	Client
	Warehouse operations.	Warehouse
	See stock, book delivery.	Client
	Warehouse operations.	Warehouse
	Warehouse operations.	Warehouse
Transport management system	Book transport.	Supply chain control tower
	Update transport information.	Transport
Real time location systems	Track transport.	Supply chain control tower
SCO	Put in instructions for new design and make ticket to Design HUB.	TOMS
	Find tickets.	Design HUB
	Find available designs.	Client
	Workstation for Design HUB.	Design HUB
Database management system	Open material code and make restrictions.	Coding and specifications
	Issue request about master data update.	Factory
	Receive request about master data update.	MDM
Business workflow management tool	Issue request about master data update.	Production B, TPI
	Receive request.	MDM

	Check availability of material.	Material and capacity planners
	Planning tool.	TOMS
Productivity/ collaborative software	Fill in template.	Client
	Track orders.	Client, TOMS, Production
	Find information for template.	Client
	Sketch design.	D&T
	Communication.	All
	Communication.	All
	Show configurations for specific machines.	Client
Manufacturing execution system	Find and manage information about production.	Client (Production)
Office of facilities and property management	Where test order demand is added.	Material and capacity planners
Company intranet	Information platform.	All
	Issue request about master data update.	TOMS
	Receive request.	MDM