BSc Industrial Engineering and Management

Optimizing Decision-Making During Product Phase-Out at Company X

Balancing Financial Risk Mitigation and Customer Satisfaction

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Preface

Dear Reader,

I am pleased to present to you my bachelor thesis entitled *Optimizing Decision-Making during the Product Phase-Out at Company X*. With this thesis I conclude my studies in Industrial Engineering and Management at the University of Twente. The research was conducted at Company X, from February 2024 to July 2024, and has given me thorough insights into practical applications of my academic knowledge.

My sincere gratitude goes to everyone who supported me during this research journey. I am very grateful to Company X for giving me the opportunity to conduct this research. My special gratitude goes to my supervisor at Company X, whose guidance and encouragement were crucial in the formation of this thesis. The operations team at Company X played an important role. They not only gave me a very warm welcome by making me feel part of their team, but also by showing genuine interest and commitment in my research. Without their insights, support and cooperation, as well as that of the sales, market solution management, and R&D team, this research would not have been possible.

I would also like to express great appreciation to my supervisors at the University of Twente, Renata Guizzardi-Silva Souza and Martijn Koot, for their expert and highly motivating guidance and feedback throughout my graduation period. They played a very important role in the writing of this thesis and without them I could not have reached these outcomes.

Sincerely,

Boín Spée
Enschede, July 2024

Management summary

This research focuses on a part of the final stage of the Product Lifecycle: the product phase-out process. Company X is facing several problems around this process. There are no clear and structured agreements, protocols or procedures, there is a lack of insight into the lifecycle op products, there are no clear information and communications lines and a division of roles is lacking. This results in high costs and loss of customer satisfaction. The aim of the research is as follows:

"The product phase-out process, *should transition from an **ad-hoc, unstructured and undefined** state (reality) to a **planned, structured and well-documented** state (norm)."*

The first six steps of the systematic problem-solving approach, the Management Problem Solving Method (MPSM), are used for this thesis. The last two steps, the implementation and testing phases, are beyond the scope of this study. The research is based on qualitative research. Information is obtained through various qualitative research methods: interviews, workshops, literature review and surveys. The workshops are used to identify the current and desired situation, the interviews are used to elaborate the process and get more detailed information, and the survey is used for final validation.

Based on a literature review, an overview is given of existing approaches, frameworks and concepts that form the necessary basis for analyzing, managing and modelling business processes, specifically focused on the product phase-out process, within Company X.

It then elaborates on the current situation and conducts a stakeholder analysis and SWOT analysis. The data used in this chapter comes from several workshops and interviews, mapping the current steps of the phase-out process and identifying inefficiencies and areas for improvement. Using Business Process Modelling (Notation), the current situation and triggers for initiating a product phase-out are modelled.

A benchmark survey is then conducted and customer satisfaction guidelines are established. The benchmark study was conducted on the basis of several interviews with representatives of other business units. The recommendations from the benchmark study include conducting semi-annual meetings, optimising the product portfolio, assigning a process owner, knowing about product life cycles, taking a long-term perspective and maximising the use of excess stock.

In addition, customer interviews revealed the need for early communication and clear information. The identified factors for customer satisfaction include timing of communication, successor costs, quality of the information and reliability of information.

The final chapter is used to develop an improved business process model, establish KPIs to measure and monitor the product phase-out process, conduct a risk assessment and provide risk mitigation strategies. The enhanced product phase-out process is initiated by proactive triggers and coordinated by a newly introduced team: the phase-out team. The main risks that have emerged from the risk assessment are financial risks and risks related to customer satisfaction. Medium-priority risks mainly relate to internal processes.

In conclusion, by taking a proactive approach, appointing a process owner, communicating on time and closely monitoring KPIs, Company X can effectively manage its product phase-out process.

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List of Abbreviations

AHP	=	Analytic Hierarchy Process
BPM	=	Business Process Management or Business Process Model
BPMN	=	Business Process Modelling Notation
BPA	=	Business Process Analysis
BP	=	Business process
CLT	=	Commercial Leadership Team
CSI	=	Customer Satisfaction Index
EEE	=	Electronic, Electrical and Electromechanical
EMS	=	Electronics Manufacturing Services
EOL	=	End of Life
FFF	=	Form, Fit and Function
KPI	=	Key Performance Indicator
LTB	=	Last Time Buy
MPSM	=	Management Problem Solving Method
MSM	=	Market Solutions Management
PDN	=	Product Discontinuance Notice
PLM	=	Product Lifecycle Management
PLT	=	Product Leadership Team
PO	=	Product Owner
RCA	=	Root Cause Analysis
R&D	=	Research & Development
SBP	=	Structured Business Process
SWOT	=	Strengths, Weaknesses, Opportunities and Threats
UBP	=	Unstructured Business Process

1 Methodology

This chapter will explain why this study was conducted and for whom this study was conducted. The chapter will begin with an introduction of the company and an introduction of the specific business unit in Section 1.1. Then the motivation and objective of the research will be explained in Section 1.2 and 1.3. The core problem will be identified through a problem cluster in Section 1.4 and the problem-solving approach is discussed in Section 1.5. The theoretical perspective is addressed in Section 1.6. For the research design in Section 1.7, the research questions and deliverables are determined, data collection methods are described, the scope and limitations of the problem are addressed, and how reliability and validity will be assured are discussed.

1.1 Company introduction

1.1.1 Business Unit 1(BU 1)

This bachelor thesis is conducted within business unit 1 of Company X.

1.2 Research motivation

Company X has not organized its product lifecycle management in a structured way, their processes are reactive and not efficient, leading to high costs. Last year, Company X lost around   euros to excess stock of obsolete components.

In the sector of technology companies and manufacturers of electronic, electrical and electromechanical (EEE) components, obsolescence is a growing problem. In these sectors, it is not unusual for 70-80% of electronic components to become obsolete even before the first system is installed (Erkoyuncu & Roy, 2014). Therefore, it is crucial for Company X to have a long-term strategy and ensure that obsolete components are identified early.
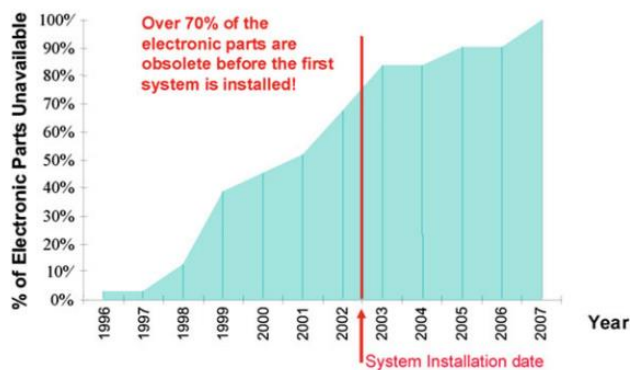
Figure 1 - Obsolete components (Erkoyuncu & Roy, 2014)

It is of even greater importance to Company X since Company X has outsourced the production of almost all of its products, making the dependence on suppliers high and the duration of lifecycles lower.

1.3 Research objective

The operations team within Company X strives to gain insights into the product phase-out process within the product lifecycle management. The research focuses on determining and understanding the current situation and creating an improved business process model that includes activities, responsibilities, and the information and communication lines. The goal is to reduce risk, control costs, increase process efficiency and maintain customer satisfaction.

1.4 Problem identification

As described in Section 1.1.1, Company X offers both software and hardware solutions to   . For all hardware products, it is of great importance to have a clear product lifecycle management (PLM) in order to properly manage the supply chain and continue to deliver efficiently. This requires planning and managing the product lifecycle, clear documentation and information management, and collaboration and communication between different teams across the supply chain. In this study, we are specifically concerned with the last stage of the PLM, the product phase-out.

Products go through different stages within their life cycle, changes in the last stage may occur due to, for example, developments of new generations, obsolescence of parts, situations where products are no longer producible or the products no longer meet market requirements. The occurrence of these changes and the phasing out of products requires various activities.

Currently, Company X does not have clear and structured agreements, protocols or procedures around the product phase-out and the activities involved. There is no insight into the lifecycle of products, there are no clear information and communication lines and a division of roles for performing the right activities at the right time is lacking. Because there is no insight into the product life cycle of products, Company X is now reactive and changes or phase-outs are handled ad-hoc. This often leads to unexpected situations.

As a result, Company X is experiencing various problems, including higher costs. These costs arise because proper inventory estimates cannot be made, resulting in either shortage costs or surplus costs. The shortage costs are the costs involved in buying shortages from the aftermarket or increased costs from suppliers. Surplus costs are the inventory costs or the costs wasted on too much inventory. In addition, the consequence of not having a clear and structured decision-making process around the phase-out stage, and thus not running the internal processes efficiently, is that customers are not informed in a timely manner with the right information, resulting in a loss of customer trust.

1.4.1 Problem cluster

As described in the previous above, Company X is facing several problems surrounding their phase-out process. The following problems are identified:

- No clear and structured agreements, protocols or procedures around the phase-out stage and the activities involved
- No insight into the lifecycle of products
- No clear information and communication lines around the phase-out stage
- Division of roles for performing the right activities at the right time is lacking
- Phase-outs are handled ad-hoc
- Higher costs due to incorrect stock estimates are experienced
- Internal processes surrounding the phase-out stage are not running efficiently
- Loss of customer trust

In this section a problem cluster is created to select the core problem and define which problems are associated problems. A problem cluster is a model of the problem situation, also called the problem context, in which all the action problems and their relationships are visualized. They are connected via arrows going from cause to effect (Löwik & Heerkens, 2017). Its purpose is to understand the problem in a broader context and bring possible causes to light.
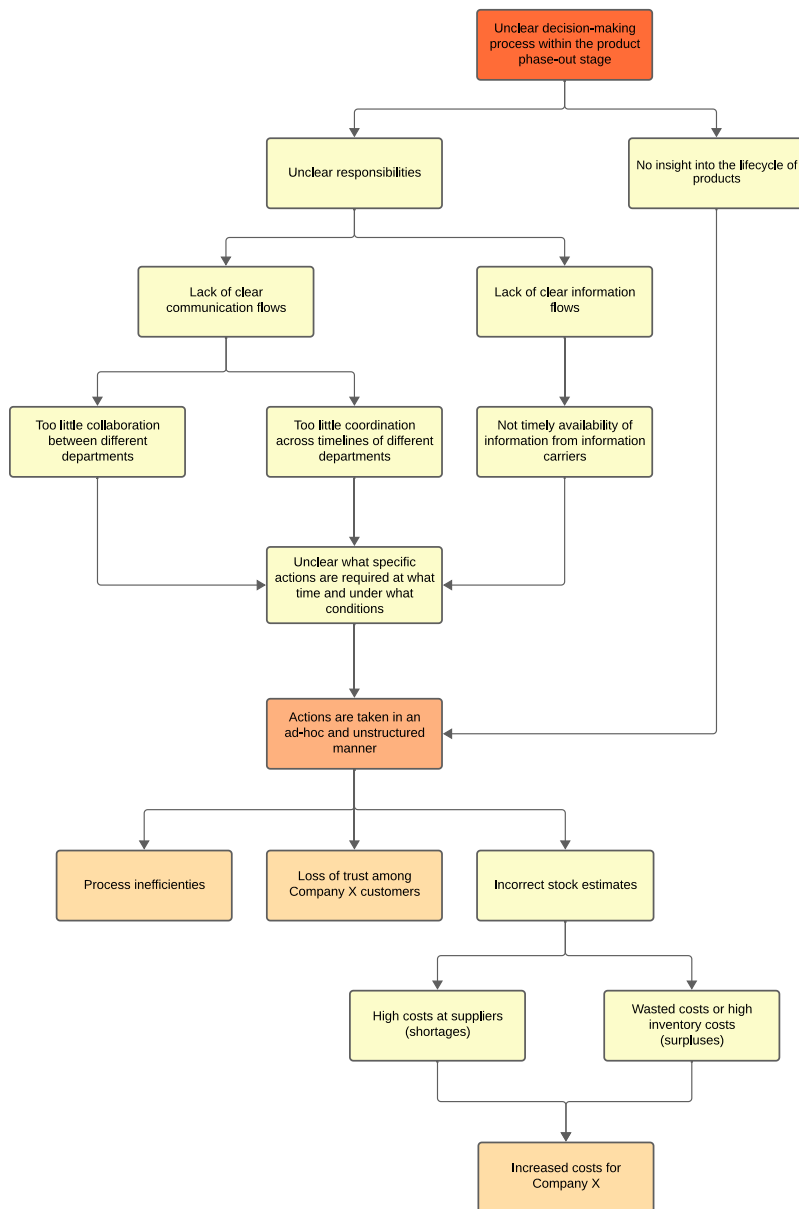
Figure 2 - Problem cluster

Figure 2 shows the problem cluster, which visualizes the core problem and the problem context. Let's start at the bottom of the figure, these are the three problems Company X is currently experiencing most severely: process inefficiency, high costs and loss of customer trust. Process inefficiency includes delays, inconsistencies, misunderstandings, performing unnecessary or duplicate activities, overlooking activities and lack of regular reviews around the phase-out process. Higher costs result from inaccurate inventory estimates, when shortages occur supplier costs will be higher, when surpluses occur there are wasted costs or inventory costs. Loss of customer trust results from not meeting customer expectations. This is due to not informing customers in a timely manner, not providing accurate and reliable information, an increase in costs or unavailability of products.

These problems arise because there is no structured approach and decisions are made in an improvised and unplanned manner during the product phase-out process. Actions are unstructured because it is not clear what activities need to be done, by whom and when. There is a lack of coordination and cooperation between different departments and information is not received by the right people at the right time. There are no clear lines of information and communication, nor can they be established because it is unclear who holds which information in the first place and where this information is supposed to go. This is because it is not clear who is responsible for activities and what the division of roles is. In addition, actions are performed in an unstructured manner because there is no understanding of product lifecycles. There is no planning and management of the different stages that products are in or can move to. All the problems described can be derived from one problem: the core problem.

The core problem is one problem, it is at the beginning of the chain and if this problem is solved then the associated problems will also improve or be solved. Based on the information gathered within the company and the problem identification section, the following core problem is selected within the problem cluster:

"Unclear decision-making process within the product phase-out stage"

Based on the problem cluster, a clear norm (what is wanted) and reality (what is actually happening) can be defined:

"The product phase-out process, within the (supplier) operations team at Company X*, should transition from an **ad-hoc, unstructured and undefined** state (reality) to a **planned, structured and well-documented** state (norm)."*

To solve the core problem, steps must be taken to improve the flow of information and communication, and an insight into the life cycle of products must be gained. Agreements, protocols or procedures must be established and the phase-out process must be documented to transform reality to the norm. A decision-making process must be established to effectively organize the phase-out in a way that the (financial) risks are minimized but without having to compromise on customer satisfaction.

1.5 Management Problem Solving Method (MPSM)

The Management Problem Solving Method (MPSM) is the systematic problem-solving approach that will be used for this thesis. This method is developed by Heerkens and Van Winden (2017) and based on different problem-solving methods. This method is used when, perceived by the problem owner, there is a difference between the norm and reality. It solves action problems by handling them in their organizational context. The MPSM consists of the following 7 steps (Heerkens & Van Winden, 2017):
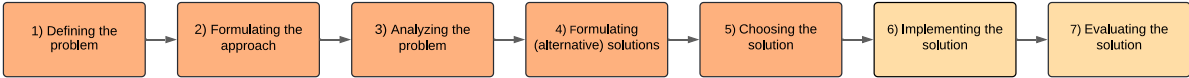
Figure 3 - The seven steps of the Management Problem Solving Method

The first phase was carried out in Section 1.4, through a problem cluster the problem was identified and a problem description was given. Phase 2 is described in this section, which deals with the problem-solving approach and the research questions involved. Phases 3 to 5 will be conducted in the next chapters. The last two phases will not be included in this research due to time constraints, but recommendations will be given on how to implement the solution. Based on the MPSM problem-solving approach, the following steps have been established

1. The first step is identifying and describing the problem. This is done via the use of a problem cluster. What action problems have been identified and what are the effects of these? A core problem is identified. Besides that the motivation and objective of the research are described.
2. Then a suitable problem-solving approach is selected; the Management Problem Solving Method was chosen. Also, the research design and data gathering methods will be determined. Qualitative methods of data collection will be used, including interviews, focus groups, literature search and a survey.
3. The third step involves mapping the current situation and its processes. What is a product phase-out and what are the triggers for starting this process? How is a phase-out being handled currently? What risks have already been identified and how are they and customer satisfaction currently assessed and measured?
4. Conduct literature and benchmark research. Through literature research, search for existing decision-making models, frameworks, languages and methods for modelling, analysing and optimizing business processes. Through benchmarking, investigate how other business units within Company X handle product phasing out and what best practices can be identified and used within BU 1.
5. The fifth step is to create a suitable decision-making model, including steps, responsibilities and communication protocols. Do a risk assessment, provide a management document and give customer satisfaction guidelines.
6. Recommendations will be given on how best to implement the decision-making model and results of the research within Company X.
7. Finally, conclusions and recommendations will be generated based on the insights.

1.6 Theoretical framework and perspective

Choosing an appropriate theory lays a foundation for the research, it provides a framework for understanding the phenomenon; identifying relevant concepts and variables and how these are related to each other, it guides as a framework for data collection and data analysis and it can increase the credibility of the research (Hecker & Kalpokas, 2024).

The theoretical perspective most aligned with the research question and goals is the *systems theory perspective*. This section will describe why this perspective is the best fit for the research, explanation of the perspective will be provided in Chapter 2.

The research focuses on creating a decision-making model to set up the phase-out process within Company X in a structured and planned manner. It concerns a dynamic system in which it is important to gain insight into how different teams are interconnected and how they communicate and cooperate with each other. Roles need to be divided and communication and information flows need to be made clear. The concept of holism applies here. It is not only about the functioning of individual teams or the execution of specific activities, but about the overall progress of the phase-out process and the coordination between different domains. It is important how these are interconnected and interdependent. By using this holistic perspective, a more integrated and coherent decision-making model can be established, focusing on the whole rather than on individual parts. In addition, the decision-making process depends on the environment; there are many different triggers for starting the product phase out process.

To conclude, the systems theory provides a holistic, dynamic and broad view of the organization. To extend this further, various methodologies and frameworks can be used to support the research. In the literature review in Chapter 2, I will delve further into these standardized approaches.

1.7 Research design

In Section 1.7.1, the main research question is formulated based on the problem identification. In addition, several sub-research questions are formulated. By answering these sub-research questions, the research can be guided and ultimately the main research question can be answered. Furthermore, deliverables will be formulated for each research question.

Section 1.7.2 will explain which data gathering and analysis methods will be used throughout the research. Finally, Section 1.7.3 will describe the research scope and limitations.

1.7.1   Research questions and deliverables

As indicated in the previous sections, Company X aims to transform from an unstructured, unplanned and undefined phase-out process to a structured, planned and well-documented phase-out process. This research focuses on developing a decision-making model that visualizes all activities, responsibilities, information and communication lines, in order to solve the problem. The main difficulties Company X is currently facing are the high costs and loss of customer satisfaction due to reactive and ad-hoc handling of the phase-out process. Based on this, the following main research question is formulated:

"How can Company X *effectively organize its decision-making process within the product phase-out stage to minimize (financial) risks without compromising on customer satisfaction?"*

The research question is composed of three main parts: establishing a standardized decision-making model for the phase-out process that can be used internally, minimizing risks for Company X and maintaining customer satisfaction. On this basis, the research is intended to produce the following final results:

- Decision-making model including steps, responsibilities and communication protocols
- Risk assessment and management document
- Customer satisfaction guidelines

To answer this research question and arrive at the deliverables, some sub-research questions and sub-deliverables are used. These are explained below.

Chapter 2: Literature Review
To effectively conduct and support the research, relevant literature must be sought. There will be a focus on identifying existing approaches and frameworks for establishing decision-making models, analysing business processes within companies and understanding business process management. Academic and reliable sources will be explored. The search will address the following research question:

1. *What are existing/standard decision-making models and frameworks used during product phase-out and for modelling business processes?*

The deliverable of this research question is an overview of existing approaches and frameworks, which provide the necessary foundation for analyzing, managing and modeling business processes, specifically focused on the product phase-out process, within Company X. In addition, essential concepts such as the product life cycle and the definition of a phase-out will be covered.

Sub-deliverable: results of literature review on existing approaches, frameworks and concepts.

Chapter 3: Analysing and developing the current situation
Based on the above paragraphs, it can be concluded that no clear business processes, documentation, guidelines and protocols are used in the current product phase-out process. Situations are handled ad-hoc and there are no specific responsibilities or activities. However, phase-outs have occurred in the past and this has involved several steps. In this chapter, the current situation is determined based on conversations and interviews with stakeholders, as well as by organizing workshops in which the current situation will be mapped. The following research question has been formulated for this purpose:

2. *What are the current stakeholders and steps in the product phase-out process?*

Part of the above question will be answered by conducting a stakeholder analysis. For the other part, the current triggers for initiating a phase-out will be identified and represented in a business process model.

To provide a comprehensive understanding of the current situation at Company X, it is useful to identify and assess the key risks and opportunities associated with the product phase-out process. The following research question is used to guide this:

3. *What are the key risks and opportunities associated with the product phase-out at* Company X*, and how are these currently identified and assessed?*

This question will be answered by conducting a SWOT (strengths, weaknesses, opportunities and threats) analysis. This analysis will be conducted based on the input gathered during the aforementioned discussions, interviews and workshops. It lays the foundation for the following chapters, which go into more detail on optimizing product phase-out and conducting a risk assessment.

<u>Sub-deliverables</u>: stakeholder analysis, business process model (BPM) and SWOT analysis

Chapter 4: Benchmarking and customer satisfaction

For this chapter, interviews will be conducted with representatives of other business units within Company X, with suppliers and with customers. The interviews with other business units will be used for benchmarking research. Interviews will be conducted regarding the phase-out process within BU 2, 3, 4 and 5. All business units have different procedures, best practices will be examined and it will be investigated which insights may be useful within BU 1. The following research question has been formulated:

4. *How are other business units within Company X (BU 2, BU 3, BU 4, BU 5) handling this problem?*

Based on the benchmarking research some recommendations will be provided.

Interviews with customers and suppliers are used to gather insights from their perspective. The goal is to gain insights into what they consider important factors, ask about previous experiences, what the strengths and weaknesses of Company X are, and whether they have any wishes or expectations about the phase-out process. It is essential to identify various factors that influence customer satisfaction, so that these can be effectively addressed. The following two research questions should be answered through these interviews:

5. *How do suppliers and customers view the product phase-out process and what are specific guidelines or expectations from them?*
6. *How can maintaining or improving customer satisfaction be effectively integrated into the product phase-out decision-making model?*

This chapter will establish guidelines and recommendations for customer satisfaction and will identify factors that affect customer satisfaction; these can be used as input to the next chapter, which will establish a decision-making process.

<u>Sub-deliverables:</u> benchmarking recommendations, customer satisfaction guidelines and recommendations, and factors affecting customer satisfaction.

Chapter 5: Decision-making model development and risk assessment

In this chapter, a decision-making model is developed and a risk assessment conducted to enhance the product phase-out process at Company X. The aim of the model is to set up the phase-out in a more proactive and structured way, so that all stakeholders know what activities should be carried out at what time and to ensure that responsibilities are clear. In this way, problems such as high costs or loss of customer confidence can be mitigated. The purpose of the risk assessment is to identify risks and establish strategies to mitigate and manage them. All the information and insights from the previous chapters will be incorporated into this model and in addition a workshop will be organized where the desired situation will be mapped out based on the perspective of the participants.

KPIs will be established to measure and manage the progress of the phase-out process. These KPIs will be of interest to Company X when they start implementing and testing the results of the research. The research questions that guide this chapter are:

7. *How can an effective decision-making model be developed for the product phase-out at* Company X*, incorporating (financial) risk management?*

The results of these research question intend to provide Company X with a structured approach to managing the phase-out process, and to ensure that risks are effectively identified, managed and mitigated.

To validate whether the research really contributed to optimizing the product phase-out process, a survey will be distributed to key stakeholders; those who participated in the research. The survey will ask whether the decision-making model contributes to making the phase-out process more structured and proactive, reducing risk and maintaining or increasing customer satisfaction.

Sub-deliverables: BPM of the product phase-out process, KPIs, risk assessment and validation

Chapter 6: Conclusion and recommendations

The last chapter provides a conclusion and final recommendations based on the findings of the research. Although implementation is beyond the scope of this research, recommendations for implementation will be given. It will include a discussion and address areas for further research. The research questions that will be answered are:

8. *How can the developed decision-making model and guidelines be implemented within* Company X?
9. *What conclusions and recommendations can be drawn from the research?*

Sub-deliverables: recommendations for implementation, and final conclusion and recommendations

1.7.2   Data gathering methods

As mentioned in the research design, the study will be based on qualitative research. Information will be obtained through various qualitative research methods: interviews, focus groups, literature review and surveys.

To identify the problem, map the current situation and obtain detailed information about specific activities, individual interviews will be conducted with Company X employees. These interviews will be conducted with representatives of the sales, market solution management, R&D and operations team. In addition, individual interviews will be conducted with the head of operations from BU 2, BU 3, BU 4 and BU 5. The purpose of these interviews is to understand the phase-out process of these business units, identify best practices, areas for improvement and establish recommendations. There will also be interviews with representatives from two customers and one supplier to identify factors that impact customer satisfaction, explore expectations from their perspective and establish guidelines.

Most individual interviews will be semi-structured interviews. According to Alsaawi (2014) this is a type of interview where the questions are pre-planned prior to the interview but the interviewer gives the interviewee the chance to elaborate and explain particular issues through the use of open-ended questions. Some of the individual interviews will be unstructured, this is a very flexible and open type of interview where the interview is similar to a conversation. The interviewee can elaborate, leading in unpredictable directions (Alsaawi, 2014).

In addition, workshops will be organized, where a focus group of 8-10 people will engage in a conversation together and where there will be worked on mapping the current situation and the desired situation. In order to get input from different perspectives and to align the phase-out process as much as possible, semi-structured focus groups will be used. Through semi-structured focus groups, information can be obtained about the current state, but there is also the possibility for free discussions about challenges and desired changes. These types of focus groups can obtain "high quality data." Participants can challenge, argue and debate with each other, and this technique usually leads to the emergence of in-depth and rich data (Alsaawi, 2014). The workshops are conducted with employees from the domains directly involved in product phase-out, this includes sales, market solution management, R&D and operations. By bringing together participants from different domains, a wide range of experiences and opinions can be identified, bottlenecks can be pinpointed, and a shared vision of the future can be formulated.

To refine the research, the results of the interviews and focus groups will be shared with the participants, this will give them the opportunity to provide feedback. In addition, a survey will be created to validate the research and its results. This survey will be sent to the focus group participants and interviewed employees.

In summary, in Chapter 2 there will be a literature review of standard techniques, frameworks and methods to provide the necessary foundation for analysing, managing and modelling business processes. In Chapter 3, individual interviews and workshops will be used to explore and map the current situation. In Chapter 4 the interviews with other business units, customers and suppliers will take place. Based on this customer satisfaction guidelines and factors can be established and a benchmarking study can be carried out. In Chapter 5, a follow-up workshop will be organized to map the desired situation and interviews will be conducted to get more details, work out specific activities and obtain feedback. Using all this input, a decision-making model can be established to improve the product phase-out process within Company X.

1.7.3 Research scope and limitations

Time: There are 10 weeks for the project proposal, getting to know the company and understanding the problem. Then there are 10 weeks for executing the research and working on a solution for the problem.

Limitations: Due to time constraints, not all phases of the Management Problem Solving Method (MPSM) can be performed. Implementing and testing the results is beyond the scope of this research.

1.8 Reliability and validity

Reliability refers to how consistently a method measures something and validity refers to how accurately a method measures what it is intended to measure (Middleton, 2023). Validity and reliability are closely related, in fact reliability is part of validity (Heerkens, 2015). To ensure that the research is reliable, all steps taken will be documented in detail. Standardized questions or criteria will be used when conducting document analysis or interviews. To ensure that my research highlights all relevant aspects and is valid, I will gather input from experts within Company X, mainly employees responsible for conducting the product phase-outs. I will regularly seek feedback from colleagues, experts and supervisors to ensure that the research stays on track. As mentioned before, the findings and information obtained during the interviews and workshops will be shared with the individuals involved. This will give them the opportunity to provide feedback and verify that the interpretations and conclusions are clear and accurate. Finally, a final validation will be conducted. This will be done through a survey, which will be sent to the employees who were part of the research. They will be asked to check and evaluate the results, conclusions and recommendations.

In Chapter 5, there will be further discussion on the reliability and validation of the research and the results of the survey will be shared.

2 Literature review

In this chapter, literature research will be conducted on standard techniques, frameworks or methods for analysing, managing and modelling business processes, specifically focused on the product phase-out process. Further, essential concepts and information that is needed for conducting the research are described. The search will address the following research question:

"What are existing/standard decision-making models and frameworks used during product phase-out and for modelling business processes?"

Section 2.1 begins with relevant literature for the systems theory perspective mentioned in Chapter 1. The product life cycle and a definition of product phase-out are described in Section 2.2. In Section 2.3, analysis methods are explored, including stakeholder analysis, gap analysis, SWOT analysis and user experience analysis. In addition, Section 2.4 provides a literature review of business process management. This includes the BPM life cycle and stakeholders in the BPM life cycle. Finally, Section 2.5 discusses business process modelling and the notation for business process modelling.

2.1 Systems theory perspective

In Section 1.6 it was explained why the systems theory perspective fits the research and how it can be useful, this section provides literature on the systems theory perspective.

Developed in the 1950s, systems theory is a framework for understanding and analysing complex systems, including organizations. Organizations are seen as dynamic and complex, and the concept of holism is used: the organization as a whole is worth more than just the individual components. System theory is aimed at explaining dynamic relationships, it focuses mainly on the interdependence between different components within systems and the influence of the environment on them. In general, systems theory focuses on three levels of observations: the environment, the social organization as a system, and human participants within the organization (Lai & Lin, 2017). The environment refers to the external context in which an organization operates. Systems are dynamic and have the potential to adapt, the understanding of the systems environment is crucial for adapting and responding effectively. The social organization refers to the internal structure and processes of an organization. All parts of a system have interdependent relationships. It is important to understand these relationships, the change in one part of the system affects other parts and possibly the whole system. The human participants within the organization are the individuals who play a role within the organization. The actions, decisions and behaviour of these individuals affect the overall functioning of the entire organization. These individuals are influenced by both the environment and the social organization (Lai & Lin, 2017).

2.2 Product lifecycle and product phase-out

This subsection deals with the definition "product phase-out" and what is meant by it. To explain what a phase-out is and how a product evolves, the product life cycle will first be explained.

2.2.1 Product lifecycle

To understand what product phase-out means, it is important to step back and look at the product lifecycle. A product goes through several stages during its lifetime, the different stages are shown in Figure 4. The first stage is the *introduction* or the *market development* stage, which is when a product is first introduced to the market, where sales are still low. Then comes the *market growth* stage, when the market expands and demand begins to grow. In stage 3, *market maturity*, there is market saturation, which means that the consumers in the target group already own or are already using the product. Demand decreases at this stage. The last stage is the *decline* stage. In this stage the product is less and less profitable, this can be due to declining demand because of technical, functional or design obsolescence (Levitt, 2024).
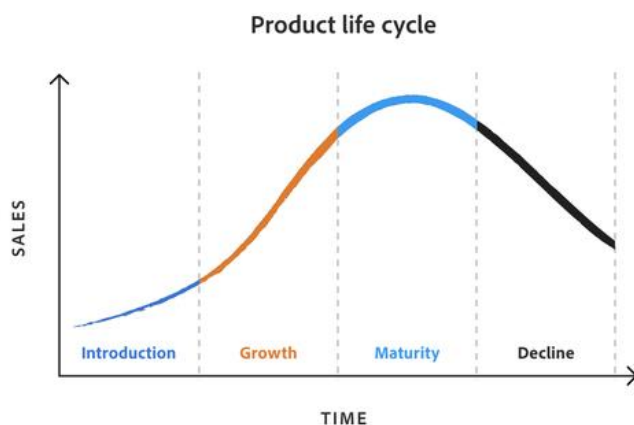
Figure 4 - The product life cycle (Adobe Communications Team, 2022)

2.2.2 Definition of a product phase-out

This research focuses on a part of the final stage of the Product Lifecycle: the product phase-out. Once decided that a product will no longer remain on the market, this can be based on various reasons/triggers, a product must be phased out. The process and steps to be taken after this decision, that is what is meant by *product [1]phase-out* in this research. This involves the announcement that a product will be a phased-out product, the final reception of demands, the final order reception, the final shipment and finally removing the product from the price list. Furthermore, activities such as removing or adjusting marketing materials, updating the product documentation, deciding on pricing and managing inventory must be carried out (Bjernulf, 2016).

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[1] *Product* in some cases can also refer to phasing out *components*, *item sets* or an entire *proposition*.

2.3 Methods of analysis

Currently Company X has nothing on paper when it comes to the phase-out process, in order to still be able to define and analyse the situation and establish a desired situation, this sub-section will examine several analysis methods.

2.3.1 Stakeholder analysis

By stakeholders are meant individuals, groups or organizations that are actively involved in the project, have some interest or level of influence that can impact the project or those that may experience a positive or negative impact because of the execution or successful completion of the project (Smith, 2000).

Stakeholders can be categorized as internal or external. Internal stakeholders come from within the organization, external stakeholders come from outside the organization. At the same time, all these stakeholders can also be grouped according to their level of involvement and impact. On this basis, they are grouped into primary and secondary stakeholders (Viter, 2024). Primary stakeholders are individuals or groups with direct influence on the project, contributing to its outcome and involved in its daily activities. Primary stakeholders see a benefit in the success of a project and therefore do not like to see it fail. Secondary stakeholders are individuals or groups with indirect involvement. They do not contribute to the project or its outcome, but can influence it, and may have an interest in the outcome of a project (Viter, 2024).

In order to analyse the influence of different stakeholders and what this means for a project, stakeholder mapping can be used. This involves identifying stakeholders, using criteria to determine which categories (internal, external, primary, secondary) these stakeholders fall into, and lastly, the level of involvement can be determined (Viter, 2023).

2.3.2 Gap analysis

Gap analysis is used when companies are not using their resources, capital and technology to their full potential. It is a method used by organizations to compare current performance with desired or expected performance. By defining and analysing the gap between the two, an action plan can be developed to move the organization to the desired situation and fill in the performance gaps. The gap analysis is used to look again at set goals and find out if a company is on the right track to achieving these goals. The analysis consists of the following steps:

1. Define focus areas
2. Identify desired future state
3. Assess current state
4. Choose the right KPIs
5. Create an action plan (Wright, 2023)

Once the gap is identified, ways must be explored to bridge it. There are many tools that can be used to do this. One of the tools that can be used for this purpose is the SWOT analysis. This is explained in the next section and conducted in Section 3.4.

2.3.3 SWOT analysis

One of the most recognized analysis tools is the SWOT analysis, it is used to determine the strengths, weaknesses, opportunities, and threats (Hayes, 2023). A SWOT analysis, according to Kenton (2023), can be defined as "a framework used to evaluate a company's competitive position and to develop strategic planning. It assesses internal and external factors, as well as current and future potential."

2.3.4 User experience analysis

User experience analysis is a method that uses the perspective and input of those who have direct interaction with the process being analysed. Interviews, surveys or focus groups with employees, customers or other stakeholders can be used to collect data about the process and its performance. Based on their experiences with the process, valuable insights and improvement opportunities can be identified (Numminen et al., 2023).

2.4 Business process management (BPM)

This section explains Business Process Management (BPM) through an introduction about the methodology, the BPM lifecycle and the stakeholders in the BPM lifecycle. The BPM lifecycle shows the steps to be taken to obtain structured and improved business processes.

Business process management can be considered as a process optimization method, it focusses on enhancing the performance of organizations by systematically managing and improving business processes. Business processes can span across different departments, specialism, geographic locations, management levels, and other organizational boundaries, this makes the management of end-to-end processes complex. To properly manage all these processes, Reijers (2021) mentions the following: "It is essential to understand the *steps* that are carried out as part of a business process, as well as the *people* who are involved in these steps, and the *technologies* that are invoked when executing the various steps." The individual behaviour of business units can only lead to sub-optimization. The coordination and integration of business processes is of great importance for the performance of the entire business process and organization. By aligning all these separate processes and making them more efficient, the entire business process can be optimized.

Structured management and improvement of business processes can be supported by the BPM life cycle, shown in Figure 5. The BPM lifecycle is shown as a circle, reflecting the fact that it is an ongoing process. As mentioned by Dumas et al. (2018), a lack of continuous improvement will lead to degradation. It is important to continuously adapt and improve to keep up with the ever-changing environment. As stated by Hammer (2015) 'Every good process eventually becomes a bad process'.
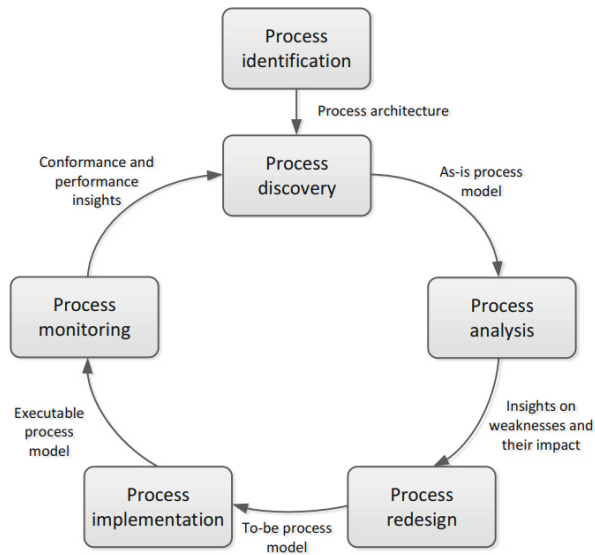
Figure 5 - BPM lifecycle (Dumas et al., 2018)

According to Dumas et al. (2018), the BPM life cycle consists of six steps. In this study, only the first four steps are performed:

- **Process identification**. This is the phase where, based on identifying and framing relevant processes around a problem, a process architecture is created. The processes and their underlying interactions are represented in this architecture. It can help to determine which processes should be managed in the next steps.
- **Process discovery**. In the second phase, the current situations of the identified processes are mapped. This is usually done in the form of one or more as-is process models.
- **Process analysis**. The process analysis phase focuses on identifying and documenting issues identified from the as-is processes. The purpose of this step is to prioritize the problems based on potential impact and the difficulty of solving the problem. Where possible, the problems should be qualified using KPIs.
- **Process redesign**. This phase can also be called the improvement phase, where the goal is to find solutions or identify changes that can be made to solve the problems identified in the previous steps and meet the organization's performance goals. The output of this phase is a to-be process model.
- *Process implementation*. For the implementation phase, it is important that the steps that need to be taken, to transform from the as-is process model to the to-be process model, be prepared and performed.
- *Process monitoring*. The final step is monitoring the processes, collecting and analysing data to determine how well a process is achieving its goals. This also involves identifying bottlenecks and restarting the BPM lifecycle when new problems arise.

For monitoring the process Key Performance Indicators can be used. According to Hennigan (2023), a KPI can be defined as a measurable target that indicates how individuals or businesses are performing in terms of meeting their goals.

2.4.1 Stakeholders in the BPM lifecycle

Throughout the lifecycle of BPM, many stakeholders are involved. These stakeholders can be divided into individuals and groups. The stakeholders involved can be categorized as: management team, process owners, process participants, process analysts, process methodologist, system engineers and the BPM group (Dumas et al., 2018). For this research, the process owners and process participants are the most important stakeholders to dive into.

Process owners are responsible for the efficient and effective operation of a given process. Their responsibility is to plan, organize and monitor the process. For the planning and organizing part, they are responsible for defining performance measures and targets, as well as initiating and leading improvement projects related to the process. For monitoring, process owners are responsible for ensuring that targets are met and, if not, that actions are taken. A process owner is thus involved in process modelling, analysis, redesign, implementation and monitoring.

Process participants are human actors who perform the activities of a business process on a daily basis. Process owners are those who coordinate them. Process participants perform routine work, based on standards and guidelines, and process owners are those responsible for non-routine work. Process participants are involved in process discovery and process analysis as domain experts and support redesign activities and implementation efforts (Dumas et al., 2018).

2.5 Business process modelling

According to Tsiri et al. (2022) business process modelling is one of the most significant notions for business process management. Using models, business processes can be documented and communicated enabling process optimization and performance assessment. It is a technique to capture, organize and communicate information about business processes (Tsiri et al., 2022). A business process, according to Dumas et al. (2018), can be defined as "a collection of inter-related events, activities, and decision points that involve a number of actors and objects, which collectively lead to an outcome that is of value to at least one customer." There are two types of business processes: structured business processes (SBP) and unstructured business processes (UBP). A SBP is a business process consisting of an ordered set of planned activities which are defined at design-time. A UBP is a business process which depends on real-time events, available data and knowledge of knowledge workers. The processes within Company X can be defined as unstructured business processes, they are goal-oriented, data dependent, emergent and require coordination and collaboration among stakeholders (Bukhsh et al., 2017).

According to Bukshs et al. (2017) the modelling languages BPMN (Business Process Model and Notation) and CMMN (Case management Model and Notation) can both be used to model UBP. Here, BPM is a more structured way with clear steps and CMMN is used for processes that need more adaptability and flexibility.

The goal of the thesis is to provide a structured and well-documented business process model. This is why it is best to use the modelling language BPMN to map the product phase-out processes.

2.5.1 Business process modelling notation (BPMN)

"Business Process Modelling Notation (BPMN) is a graphical notation that describes the logic of steps in a business process. This notation has been especially designed to coordinate the sequence of processes and messages that flow between participants in different activities" (Bizagi BPM, 2017). Using BPMN, processes can be modelled in a uniform and standardized way, allowing everyone in an organization to understand each other and thus reducing the gap between business processes and their implementation. It is an internationally accepted standard for process modelling, which allows parties to communicate processes clearly, completely and efficiently. In this thesis, the BPMN 2.0 notation in the Bizagi program is used for modelling.

The four elements used within BPMN are the following:

- **Flow object**s: events, activities and gateways
- **Connecting objectives**: sequence flow, message flow, association
- **Swim lanes**: pool or lane
- **Artifacts**: data object, group, annotation (*What Is Business Process Modeling Notation*, n.d.).

Events: An event is a trigger that starts, modifies or completes a process. They are represented as circles containing a symbol (based on the event type). Event types can be a message, timer, error, compensation, signal, cancel, escalation, link or other and they are categorized as either 'throwing' or 'catching' (*What Is Business Process Modeling Notation*, n.d.).

Activity: An activity is represented by a rectangle with rounded corners. It represents a specific activity or task performed by a person, team, organization or system within a business process. Activities can be made more detailed by using subprocesses, loops, compensations and multiple instances (*What Is Business Process Modeling Notation*, n.d.).

Gateway: A gateway is a decision point that can adjust the path based on conditions or events. They capture forking and joining paths in the control flow. A gateway is shown as a diamond, based on what kind of gateway it is, a matching symbol is displayed in this diamond. There are exclusive (XOR), inclusive (OR), parallel (AND), complex, and event-based gateways (*What Is Business Process Modeling Notation*, n.d.).

Sequence flow: The sequence flow is an arc that shows the order of activities to be performed. It is a straight line with an arrow and can be used for conditional flows and for standard flows (*What Is Business Process Modeling Notation*, n.d.).

Message flow: This type of flow is represented as a dotted line with a circle at the start point and an arrow at the end point. It can only be used to represent messages flowing between pools; it cannot be used to connect events or activities within the same pool (*What Is Business Process Modeling Notation*, n.d.).

Association: It is used to associate an artifact or attach a note to an event, activity or gateway. It is displayed as a dotted line (*What Is Business Process Modeling Notation*, n.d.).

Pool and swim lane: Pools and lanes are used to represent roles, departments and organizations. Pools represent key participants; another pool can mean another company or department. Lanes within these pools are used to define who is responsible for activities and flows within a process (*What Is Business Process Modeling Notation*, n.d.).

Artifact: These are used to add more detail to the model. A *data object* is used to show what data is needed as input to an activity and what data is output from an activity. A *group* shows a logical grouping of activities and an *annotation* is used to provide further explanation. (*What Is Business Process Modeling Notation*, n.d.).

The visualizations of the above elements can be found in Appendix B.

3 Analysing and developing the current situation

This chapter will analyse and establish the current situation, as there is no clear current situation at this moment. The research questions that will be addressed are as follows:

"What are the current stakeholders and steps in the product phase-out process?"

"What are the key risks and opportunities associated with the product phase-out at Company X*, and how are these currently identified and assessed?"*

These research questions will be answered based on information obtained through interviews and workshops with stakeholders. Section 3.1 will begin by discussing the data collection of the current situation. To determine which stakeholders are relevant to the research, a stakeholder analysis will be conducted in Section 3.2. Using Business Process Modelling (Notation) the current situation and the triggers for starting a product phase-out will be modelled in Section 3.3. In addition, a SWOT analysis will be conducted in Section 3.4 to identify the strengths, weaknesses, opportunities and threats of the phase-out process for the current situation.

3.1 Data collection of the current situation

As indicated in the problem identification in Section 1.4, there are currently no clear business processes, documentation, guidelines and protocols used in product phase-out. The BPM life cycle from Section 2.4 shows the various steps that must be taken to transform into a structured and improved business process. After identifying the problem, the next step is to map the current situation of the identified process. This is done in the form of an as-is model.

The as-is model is established through a workshop, which brings together a focus group of eight people. These eight people are employees from the sales, market solution management (MSM) and operations team. From sales, the head of internal sales, the key account manager and a sales and account manager were present. From the MSM, two head product managers were present and from the operations team, a project manager (Company X's supervisor for this thesis), the change coordinator and the supplier operations manager were present.

During this workshop, participants were instructed to elaborate on the current situation. To begin, they had to individually brainstorm about the activities that are currently being performed or that have taken place in the past during product phase-out. Next, they had to write these activities on post-its. A large paper was present, divided into a number of lanes. These lanes represented different teams involved in the phase-out process. Some lanes had been filled in prior to the workshop, while others were left blank so that the teams and other stakeholders involved could be identified during the workshop. The post-its containing all activities were pasted on the paper based on a discussion with each other, omitting duplicate activities and clustering matching activities. The post-its were to be pasted within the team performing the activity and in the order in which it is currently done. Appendix A contains some images and visualizations of what these layouts, mapping and results looked like.

During the workshop it emerged that the timeline of activities is not clear in the current situation and that several essential activities are missing at the moment. It emerged that somewhere in the back of their minds the participants know which activities should actually be carried out but at the moment no one takes responsibility for actually carrying them out and coordinating the process. Because there is no standard order for carrying out activities, it has already occurred a number of times that the timelines of different teams are not aligned and therefore the process does not run efficiently.

Another workshop was organized to identify the key decisions to be made during the product life cycle. During this workshop, different teams had to complete a pre-established matrix. The participating teams were MSM, R&D, and the operations team. Each team had to complete the matrix, and at the end of the session, the teams presented their results to one another. The most important and overlapping decisions were noted. The pre-established matrix and relevant results, specifically those related to the product phase-out, can be found in Appendix A.

During the workshop, teams wrote down what they felt were the most important decisions to make at each stage, who is currently responsible for making these decisions, what inputs are needed to make the decisions, and what the outputs of these decisions are. If there were decisions with unclear responsibilities, they left them blank or filled in a question mark. The workshop revealed that different teams do not always have the same idea about who is responsible, and sometimes there is no idea who is responsible at all.

After the workshops, several individual interviews were organized with the participants to elaborate on the process, get more details and check if the results of the workshops matched how they thought the current process was going. In addition, there was a semi-structured interview with the change coordinator of the operations team. In this, information was obtained on what the current triggers are for phasing out products and on the current obsolete management process.

The information obtained through the workshops and interviews will be used as input for the rest of the chapter.

3.2 Stakeholder analysis

In this sub-section a stakeholder analysis is conducted, the literature used for this is described in Section 2.3.1.

Several parties are involved in developing an integrated decision-making model, including responsibilities and lines of communication, and in establishing guidelines and protocols for the phase-out of products. Figure 6 charts all the stakeholders involved in this research. The parties most involved in the research and most affected by the solution are placed around the centre (primary stakeholders). The further the parties are from the centre, the less they are part of the research, have an interest in the outcome or feel any impact (secondary stakeholders).

Primary stakeholders are those who are directly involved in the project and contribute to the outcome. These can be either internal or external parties. Secondary stakeholders are the parties indirectly involved in the project, they do not contribute to the project or the outcome but have an interest in the project and its outcome. All stakeholders identified above are categorized in Table 1 by internal or external and primary or secondary.

Figure 6 - Stakeholder mapping

Stakeholders	Primary	Secondary
Internal	• Operations • Sales • Market Solutions Management • Product Owners / R&D	• Quality Operations • Support • Launch Team • Technical operations • Finance • Marketing Communication • Product teams •
External	• Customers • EMSs (suppliers)	• Distributors •

Table 1 - Types of stakeholders

Based on the workshops and the interviews, it emerged which teams should be involved in the phase-out process. These are all the teams that must undertake activities to realize the phasing out of a product. This includes the following teams: operations, sales, market solution management and R&D. These four teams can thus be classified as internal primary stakeholders. These are the stakeholders that are part of the solution, and who have to execute the activities around the product phase-out process. Some of the work processes and activities

that they are performing may be replaced, modified, added or removed as a result of this research.

Based on the workshops and the interviews, it also emerged that the phase-out process may depend on Electronics Manufacturing Services (EMS). An Electronics Manufacturing Services is an electronics manufacturer that produces products using customized controls. Company X has selected six of these manufacturers to produce almost all Company X products. Since the production of most products is not done internally but is outsourced, several dependencies arise and the EMSs become important stakeholders. As described earlier, primary stakeholders are those directly involved in the project and its outcome, this is the case for the EMSs. The trigger of a phase-out may come from them and the outcome of the study may affect procurement activities. In addition, an important stakeholder is the customer. The phasing out of products has a direct impact on the customers and their satisfaction but also on the actions they must then take to continue to supply their customers, the   , in turn. The EMSs and customers can thus be classified as external primary stakeholders. During the research, two customers and one EMSs will be interviewed and their input on customer satisfaction, guidelines or expectations will be included in the research.

Secondary stakeholders are those who may notice differences after successful implementation of the research but are not part of the research itself. For example, the support team may notice that they get less questions regarding a LTB or the Marketing Communication team may have to adjust their marketing materials.

3.3 Triggers for initiating product phase-out

From the interviews and workshops, several triggers emerged for initiating a product phase-out within Company X. The following three were identified:

1. Obsolete component notification
2. No commercial demand
3. New generation / product development

The following sections will further explain these triggers. Mainly the first trigger, the obsolete component notification, will be explained. This is by far the most common trigger for phasing out products in the current situation; this is the case nine out of ten times. The current steps taken to mitigate or prevent the risks of this will be explained using a business process model.

3.3.1   Obsolete component notification

The obsolete component notification can come from two directions:

- From the change coordinator within Company X
- From the supplier or EMS

In the current situation, the change coordinator within Company X checks the most important products once a month and the other products once every 3 months on high risk or obsolete components. By 'high risk' an End of Life (EOL) of less than 5 years is meant. This is checked using the database from   .

. However, past experience has shown that this program cannot be completely relied upon. There have been several cases where the lifetime expectancy was still over 5 years in   but the component was no longer available. In reality, the lifespan often expires faster than expected. Once a component is estimated to last less than 5 years, the change coordinator issues a notification.

In addition, a Product Discontinuance Notice (PDN) may come from the suppliers. This is a notification from the suppliers about the discontinuation of certain products or components. This notification can be sent based on various reasons, this may have to do with obsolete components, but also if production processes change or if production is no longer economically viable.

The notifications mentioned above are often handled using a reactive approach to obsolescence management. A reactive approach to obsolescence management relies on taking action once a component event such as the release of a Product Discontinuance Notice (PDN) has already occurred. Although actively looking for critical components sounds like a predictive approach, acting on these triggers is not predictive at the moment. By the time the change coordinator's notification is acted upon, it is often too late and the components or products are no longer available. The change coordinator's input is very valuable, but is currently not being used in a proactive manner. In the desired situation, proactive approaches would be used, focusing on predicting component obsolescence before the PDN is issued.

During the interview with the change coordinator it emerged that when an obsolete component notification has taken place there are a number of obsolescence management strategies that are applied. The steps that are taken in this process are also called the change management process within Company X.

3.3.1.1 Change management process

There are different types of obsolescence management strategies: mitigation and resolution strategies. The term 'mitigation' refers to the measures taken to minimise the impact or likelihood of having an obsolescence problem, whereas the term 'resolution' refers to the measures taken to tackle an obsolescence issue once it appears (Erkoyuncu & Roy, 2014). As mentioned earlier, reactive strategies, also known as resolution strategies, are primarily used. Figure 7 shows the resolution strategies currently used by Company X.
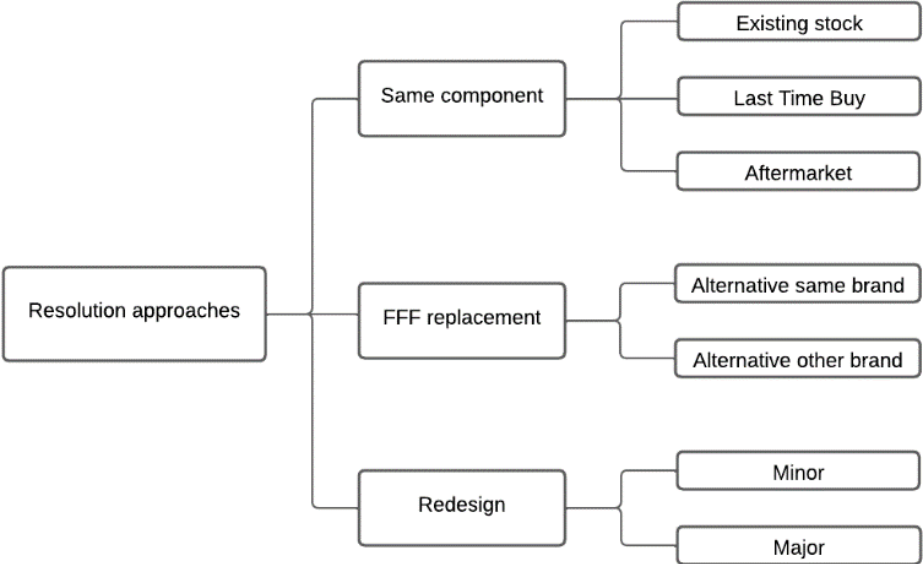
Figure 7 - Resolution strategies currently used within Company X

The resolution approaches are divided into three groups: same component, FFF (form, fit and function) replacement and redesign. The first group is used as a solution to provide the product during its life cycle or to bridge the period of finding an alternative or redesigning. Then there is the FFF replacement, an alternative is sought to replace the obsolete component without requiring a redesign of the product. The last approach is to re-design the product to one where the obsolete component is no longer used, in this approach the costs can quickly become high and it can take a lot of time.

The current decision-making process around this obsolescence management strategies is visualized in Figure 8. The Business Process Modelling Notation (BPMN) is used to model this process, which is explained in Section 2.3. The BPMN Symbols Legend can be found in Appendix B.
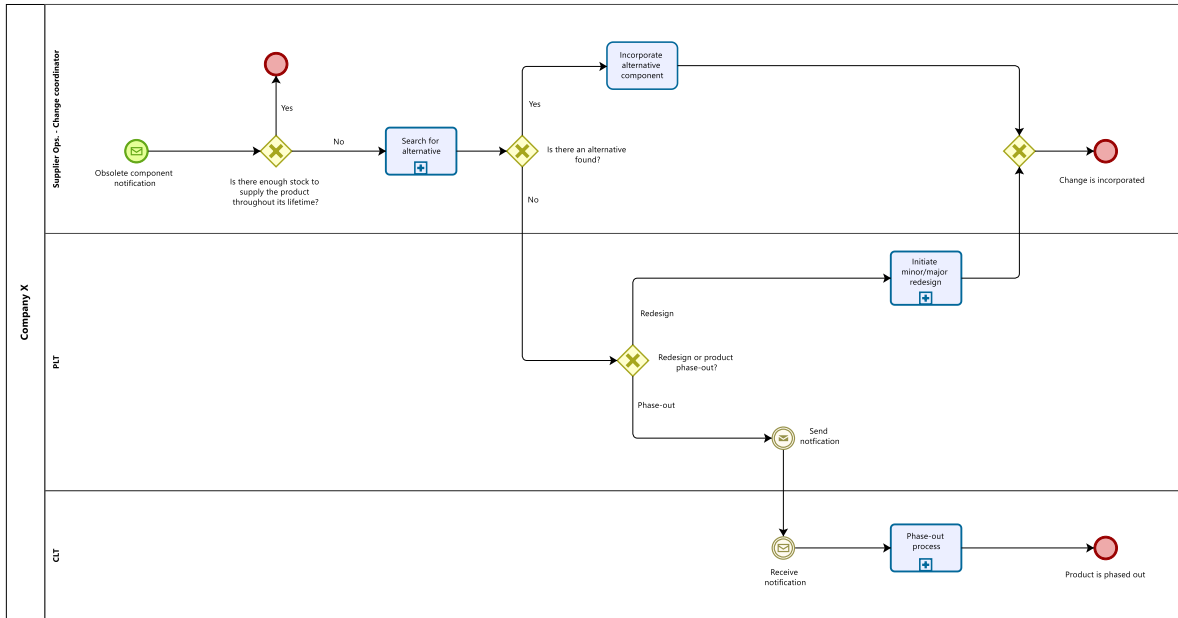
Figure 8 - Change management process around the obsolete component notification

The process is started when a component has become obsolete, this can be based on a PDN from the supplier or can be initiated by the change coordinator within Company X. The first thing to check is whether the current stock is enough to supply the product throughout its lifetime; this is the **same component resolution strategy**. Then it should be investigated whether an alternative component is available, the **FFF replacement resolution strategy**. The search for an alternative is a sub-process and will be explained in more detail below.

If an alternative is found, this new component is processed in the parts lists and once it is incorporated, the process is terminated. If no alternative component can be found, a decision must be made as to whether a redesign can take place in which the obsolete component is not used or whether the product containing the component should be phased out. This decision is made by the product owners of the product in question, criteria that are considered are the current stock, whether a new generation is already being worked on, if there are developments of new products, whether a major or minor redesign is required and how (economically) important the product is to Company X. Once a decision is made to redesign a product, the process continues in the subprocess that initiates a minor/major redesign, which will be explained later. This is the **redesign resolution strategy**.

If no redesign is chosen but it is decided that the product should be phased out then the process moves on to the product phase-out process. This is the process where the core problem is identified, it is currently unstructured and undefined. An improved decision-making model for the product phase-out process will be established in Chapter 5.

3.3.1.2 Sub-processes

Figure 9 shows the **search for alternative** sub-process. This sub-process is started as soon as the "search for an alternative" activity is started in the main process. First, an alternative component within the same brand must be searched for. If an alternative is found within the same brand, the sub-process can be terminated by 'alternative is found'. If no alternative is found within the same brand, alternatives should be searched for with other brands. If this alternative cannot be found, the subprocess can be terminated by 'alternative is not found'. If an alternative is found, samples have to be ordered and once these samples are received, they have to be tested. Based on this, the alternative can be assessed. If the alternative is approved, the subprocess can be terminated by 'alternative is found'. If the alternative is not approved, it must be checked again if an alternative can be found and the sequence must be followed again.
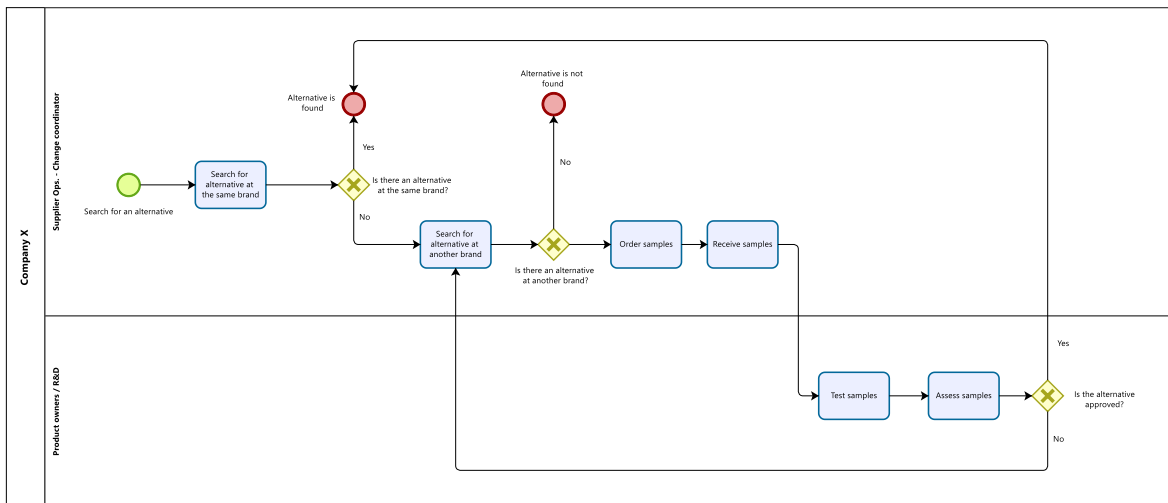
Figure 9 - Search for an alternative (sub-process)

Figure 10 shows the **initiate minor/major redesign** sub-process. This sub-process started when the condition "start redesign" is met. The first activity is to check the current inventory. This information is used by R&D to plan the redesign process. Insights must be gained as to whether it is a minor or major redesign and what the lead time of the redesign will be. This information must be sent back to the supplier operations team. Based on this, they can then forecast the number of components that will be needed during the lead time of the redesign. This is where the **same component resolution strategy** is again applied. If the current stock is greater than the forecast estimate, the current stock is used to bridge the redesign lead time. If the current stock is less than the forecast estimate, an LTB order must be placed. The number of the LTB order + the current stock together must bridge the redesign lead time. The moment shortages occur, additional components must be purchased at the aftermarket. Aftermarket prices are extremely high, so Company X has to avoid this. The next activities are to redesign the product and incorporate the new design. Once these activities are completed, the sub-process can be terminated.
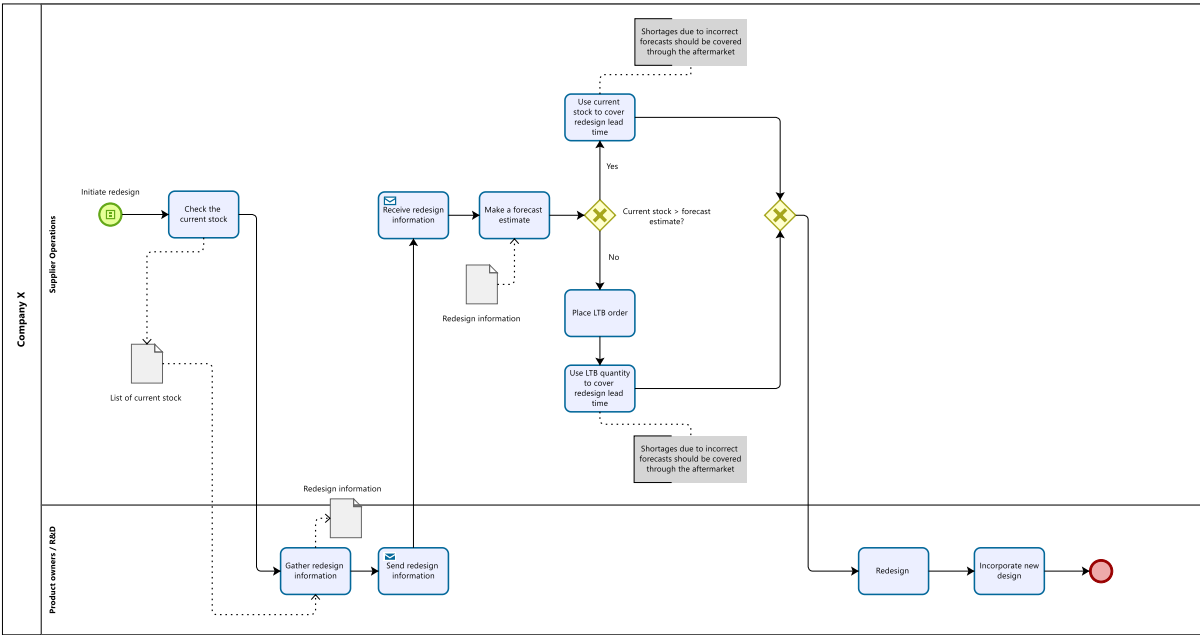
Figure 10 - Initiate minor/major redesign (sub-process)

There are two other triggers for initiating a product phase-out. These triggers are described in sections 3.3.2 and 3.3.3. In the current situation, these occur rarely, about once out of 10 cases. The goal of this study is for these to become the main triggers in the future. Steps and recommendations needed to achieve this will be explained in the next chapters.

3.3.2   No commercial demand

The moment the demand for products declines or there is no longer any demand for a product at all, a decision must be made that a product will be phased out. The same applies when a product is no longer profitable, or in some cases even costs money. There are several factors that can cause the demand for products to decrease, this can be due to changing fashion and trends, increased competition, lack of innovation from the company and changing customer preferences (*Decline Stage - Definition, Importance & Factors*, 2020).

3.3.3   New generation / product development

The last trigger is a proactive trigger. Proactive can be defined as "taking action by causing change and not just reacting to change when it happens" (Cambridge University Press, 2024). The most important aspect of this trigger is that the product phase-out process is planned in advance. Based on various aspects, it is determined several years in advance which and when products will be phased out. An estimate is made of how long a product can be sold on the market before it becomes obsolete for any reason. A phase-out date is set based on this estimate. A newer version or alternative solution must then be available before the product becomes truly obsolete.

3.4 SWOT analysis

Through the problem identification, interviews and workshops, an understanding of the various challenges, bottlenecks, and risks is developed. Based on this, a SWOT analysis is performed to assess the strengths, weaknesses, opportunities and threats of the phase-out process within Company X. The SWOT analysis is shown in Figure 11. The aim of this analysis is to provide a strategic overview, highlighting areas that need improvement and areas that should be sustained.

The insights gained from the SWOT analysis will be used in the development of the decision-making model and the risk assessment in Chapter 5.

STRENGTHS
- Innovative proposition
- Experience and expertise
- Reputation
- Strong customer and supplier relationships

WEAKNESSES
- Handling situations ad-hoc
- Information fragmentation
- Lack of insights in the PLM
- Too large product portfolio
- Reactive approach

OPPORTUNITIES
- Improve communication and integration between teams
- Structuring processes and decision-making
- Employee awareness and engagement
- Proactive approach

THREATS
- Market change
- Dependency on external parties
- Declining lifespan of technical components
- Competitors
- Complexity of the PLM

Figure 11 - SWOT analysis

In summary, in the current situation, methods are used to mitigate and reduce risks and to identify obsolete components in advance. However, these are not acted upon and the trigger for phasing out products is almost always reactive. The purpose of the following chapters is to make the phase-out process more proactive, provide recommendations on how this can be realized, and represent the phase-out process in a structured and well-documented manner.

4 Benchmarking and customer satisfaction

A benchmarking study will be conducted on the basis of two interviews with representatives of other business units within Company X. Based on this, recommendations will be given on how the product phase-out process proceeds at other business groups and what can be learned from this by BU 1. Answering the research question:

"How are other business units within Company X (BU 2, BU 3, BU 4 and BU 4) handling this problem?"

In addition, interviews will be conducted with one supplier and two Company X customers to establish expectations around the product phase-out and provide guidelines and recommendations in the area of customer satisfaction. The following research questions will be answered:

"How do suppliers and customers view the product phase-out process and what are specific guidelines or expectations from them?"

"How can maintaining or improving customer satisfaction be effectively integrated into the product phase-out decision-making model?"

4.1 Benchmarking

Two individual semi-structured interviews were conducted with representatives of business units. The first interview conducted was with the head of operations from BU 2 and BU 3. The other interview was conducted with the head of operations from BU 4 and BU 5. As described in section 1.7.2, for semi-structured interviews, the questions are prepared in advance but the interviewer does give the interviewee an opportunity to elaborate and explain certain issues through open-ended questions. The questions prepared in advance of the interviews can be found in Appendix C.

A benchmarking study was conducted based on these interviews. Benchmarking can be defined as: A technique in which an organization measures its performance against that of best-in-class organizations, determines how those organizations achieved their performance levels and uses the information to improve its own performance. Subjects that can be benchmarked include strategies, operations and processes (ASQ Quality Press, n.d.). It is recognised as an essential tool for continuous improvement of quality (Dattakumar & Jagadeesh, 2003). For this research, processes of business units of the same company are considered instead of comparing with processes of other companies. All business units within Company X serve a different market, but all in the same direction:

. So, the business units can certainly learn from each other and identify best practices through benchmarking studies.

4.1.1 Recommendations based on interviews with other business units

The interviews conducted with employees of other business units were aimed at mapping their approach in the phase-out process and identifying possible differences or similarities. These interviews revealed that the other business units are much more proactive or are currently in the process of transitioning to a more proactive approach.

The main difference identified during the interviews is that the other business units hardly ever experience the "obsolete component notification" as the starting point of the product phase-out process, only in one out of ten instances, whereas for BU 1 this is the case for nine out of ten instances. The other business units manage to introduce a newer version or another concept themselves before components become obsolete. BU 1 aims to work toward this situation and thus can learn from the phase-out process of the other business units.

What steps are the other business units taking so that they can act in a proactive and structured manner? Based on the insights gained from the interviews, the following recommendations can be drawn.

1. Conduct semi-annual meetings
Once every six months there should be a PLM meeting with representatives from finance, sales, operations and R&D. During these meetings, anyone may come up with input on product phase-out initiatives. The check for critical components that the change coordinator performs once every 3 months should be included as input here. All input should be reviewed at the meeting and ultimately the year in which the component, product or proposal should actually be phased out must be determined. These meetings are thus a periodic evaluation of the product portfolio.

2. Optimize the product portfolio
The goal is to get the product portfolio as small and optimized as possible. For this purpose, products that are no longer sold or are no longer profitable should be removed from the product list and the product list should be evaluated regularly. The fewer products there are in the product portfolio, the better the overview is and the tighter and more efficient the processes can be. In addition, costs can be saved on inventory management, production and marketing and quality can be better assured. Currently, BU 1 has more than   products on its product list. In contrast, BU 2 has only   . This huge difference may be the cause for there being much less overview and insight into the PLM at BU 1 than at BU 2.

3. Assign a process owner
In the other business units, there is clarity about who is responsible for which processes and a process owner has been assigned. As described in Chapter 2, process owners are responsible for the efficient and effective operation of a process. They are also responsible for planning, organizing and monitoring the process. In this case, the process owner must initiate the semi-annual meetings and coordinate the process when a product is phased out. In two business units the head of operations has been assigned as process owner and for the other two business units the MSM team has been assigned this role. In BU 1, there are no clear agreements or divisions of roles for this and it therefore often happens that work is done inefficiently, that things are overlooked or that it does not happen at all.

4. Know about the lifespan of products

An average product lifespan of seven to 10 years is expected. This can provide guidance in planning and thinking ahead in terms of the PLM. BU 1 now has a situation where an important product, which has been on the market for seven years, has become obsolete. R&D did not start working on a successor until the product became obsolete, and now needs another 1.5 years to develop a redesign. If this guidance had been followed earlier, they could have anticipated the obsolescence of the product. This would have allowed R&D to start the redesign 2 or 3 years earlier, so that the new design was ready before the original product became obsolete.

5. Take a long-term perspective

Phase-outs in the other business units are announced two to three years in advance. This long-term perspective allows the product phase-out process to run smoothly and there is sufficient time to involve all stakeholders. With this proactive approach, Company X and its customers are not faced with surprises and there is sufficient time to gradually phase out demand, production and inventories while phasing in a new concept or newer version.

6. Maximize use of excess stock

A structured set of steps and actions are used to obtain as much value as possible from the excess stock. For example, it will be considered whether it can be used for other products within Company X, at one of the EMS or perhaps sold to an external party. The exact steps taken will be included in the decision-making model from Chapter 5.

The implementation of these insights and recommendations can offer BU 1 the opportunity to establish a more efficient and structured product phase-out process.

4.2 Customer satisfaction

Individual interviews were conducted with representatives of two key customers and one supplier. The customer representatives are both product managers and the supplier representative is the supply chain management manager. Again, semi-structured interviews were used. The pre-arranged questions can be found in Appendix D and E. The interviews were conducted to determine satisfaction with the product phase-out collaboration and communication. In addition, any expectations, guidelines or wishes for the future were collected. The aim is to identify factors which are important for customer satisfaction during product phase-out.

In Section 4.2.1 the guidelines and recommendations emerged from the interviews will be described. In Section 4.2.2, the factors, compiled from the interviews, which affect customer satisfaction around the phase-out process will be explained.

4.2.1 Customer satisfaction guidelines and recommendations

Since the relationships between Company X and its customers often go back many years, the cooperation and relationship are very good. There is always much willingness to help each other and communication often runs smoothly. The pitfall that comes with these long-standing contacts is that there are often no clear business agreements, protocols or overviews. Actions and communication are currently based on gut feeling. In the future, it is recommended that more things be recorded and **clear structures, procedures and protocols** be established.

The interviews revealed that within the current phase-out process, the right or full number of customer employees are not always involved. There have been several situations in the past where only the product manager was notified about a phase-out but the other departments were not informed. This could be improved by creating a **communication matrix**. This matrix provides a clear overview of which persons should be involved and how they can be approached. This matrix should be updated annually. This can also help in case new employees are hired at either Company X or one of the customers and in creating more structure.

Third, it has emerged that use of **standardized communication methods and technologies** can optimize the phase-out process. The use of dashboards and EDI could be helpful. EDI stands for Electronic Data Interchange, this is an intercompany communication of business documents in a standard format. The use of common dashboards could provide more integration and overview. These dashboards could include open orders, inventories, deliver quantities, critical components and the year of phase-out. BU 2 uses such a dashboard. If it is decided in the PLM meeting that a product should be phased out, even if this is over a very long period of time, the dashboard is updated. The same kind of dashboard or portal can also be created for Company X, as soon as there are changes in the product life cycle phases of products, it should be displayed here. This helps Company X to be transparent in his or her developments and involve customers early in the process.

Lastly, it was indicated that it would be ideal if there were an **overlap period** to make the phase-out run more smoothly and to reduce risks. By this overlap period is meant that there is a period of time where both the new and old versions of a product are available. This period can ensure that the product can be phased out in a gradual manner and that there can be continuous delivery.

4.2.2 Customer satisfaction factors

Based on the interviews, the following customer satisfaction factors were established:

- Timing of the communication
- Successor costs
- Quality of the information
- Reliability of the information

Timing of the communication

The interviews revealed that communication is key. For customers, this is the most important factor affecting their satisfaction with the phase-out process. The earlier communication takes place, the better. Customers are ideally informed about phase-outs two to three years in advance, this way they still have enough time to look for solutions and adapt.

Successor costs

When a product, part or article series is phased out, Company X must work with its customers to find alternatives or replacements. This is also called a successor, which takes over the task, place or position of its predecessor. To maintain customer satisfaction, this successor must not be more expensive than its predecessor.

Quality of the information

Customers consider the quality of the information they receive very important. If there is early information, but this information is not relevant, it is of no use to customers. A balance must be found between early communication and the accuracy and relevance of the information. Based on the information, the customer should be able to determine and understand the impact. It should be detailed, relevant and structured information. The LTB information should also be detailed, giving an estimate of the order quantity that is possible, the date of the LTB and finally what the LTB delivery process will look like.

Reliability of the information

The final customer satisfaction factor is data reliability. Information transmitted to customers must be reliable and accurate. Customers want to be able to rely on and build on the information about alternatives, deadlines, quantities or other changes that occur. That way, clients can prepare, adjust and take appropriate actions.

5 Decision-making model development and risk assessment

In this chapter a decision-making model including steps, responsibilities and communication protocols for the product phase-out at Company X will be developed. In addition, a risk assessment will be conducted to identify and manage any risks. It will answer the research question:

"How can an effective decision-making model be developed for the product phase-out at Company X, incorporating (financial) risk management?"

Finally, recommendations and guidelines will be provided on how best to implement the decision-making model within Company X. This will answer the research question:

"How can the developed decision-making model and guidelines be implemented within Company X?"

As described in section 1.7.2, different types of qualitative research methods were used to gather insights and information about the phase-out process, which include: interviews, workshops, observations, benchmarking and literature review. In Chapter 3 the current situation was mapped, in this chapter the desired situation will be outlined. Based on the differences between these two situations and all other data, the gap could be determined. In this chapter, an improved BPM will be established to close this gap and to structure and optimize the phase-out process within Company X. Additionally, Key Performance Indicators will be established that can be used to measure, monitor and improve the execution of the phase-out process.

5.1 Data gathering

In Chapter 3, the current situation was mapped through a workshop. In this chapter, a similar workshop is organized to map the desired situation. The workshop is conducted with the same participants. The findings and results of the first workshop served as input for the second workshop. The activities and triggers identified from the first workshop are written on post-its prior to the workshop. In addition, another large sheet of paper is divided into several lanes. These lanes are filled prior to the workshop with the stakeholders and teams identified during the previous workshop. There will also be lanes left blank to assign any new roles or teams.

During the workshop, participants were asked to outline the desired situation. In doing so, they could use the post-its with previously identified activities, but also write down new activities that are not currently being carried out, but should be carried out or would be useful to carry out. Two different colours of post-its were used to effectively identify the difference between the current and desired situation. Through discussion, participants were asked to allocate all the activities to the teams that are supposed to perform the activities or assign them to a new role. In addition, the post-its containing the activities must be pasted in a desired time sequence. Appendix A contains some images and visualizations of what these layouts, mapping and results looked like.

After the workshop, again several individual interviews were organized with the participants to elaborate on the process, get more details and check if the results of the workshop matched with their intentions. After the decision-making model was developed based on these sessions, it was presented to all stakeholders for feedback.

5.2 The decision-making model

5.2.1 Developed change management process

As described in Chapter 3, there are currently three different triggers for initiating a product phase-out process. In the desired situation, the first trigger, an obsolete component notification, should no longer be a trigger for starting the process. Instead, the process will be started using a notification trigger from the Product Leadership Team (PLT). The PLT should initiate product phase-outs early with input from the so-called PLM list. The PLM list is an overview of products and their lifecycle stages indicating the desired phase-out year. Which products are on this list and the year of phase-out should be determined through a semi-annual meeting where employees from MSM, sales, operations and R&D attend and provide input. Figure 12 shows an improved business process model for what the change management process, including the various triggers, should look like.
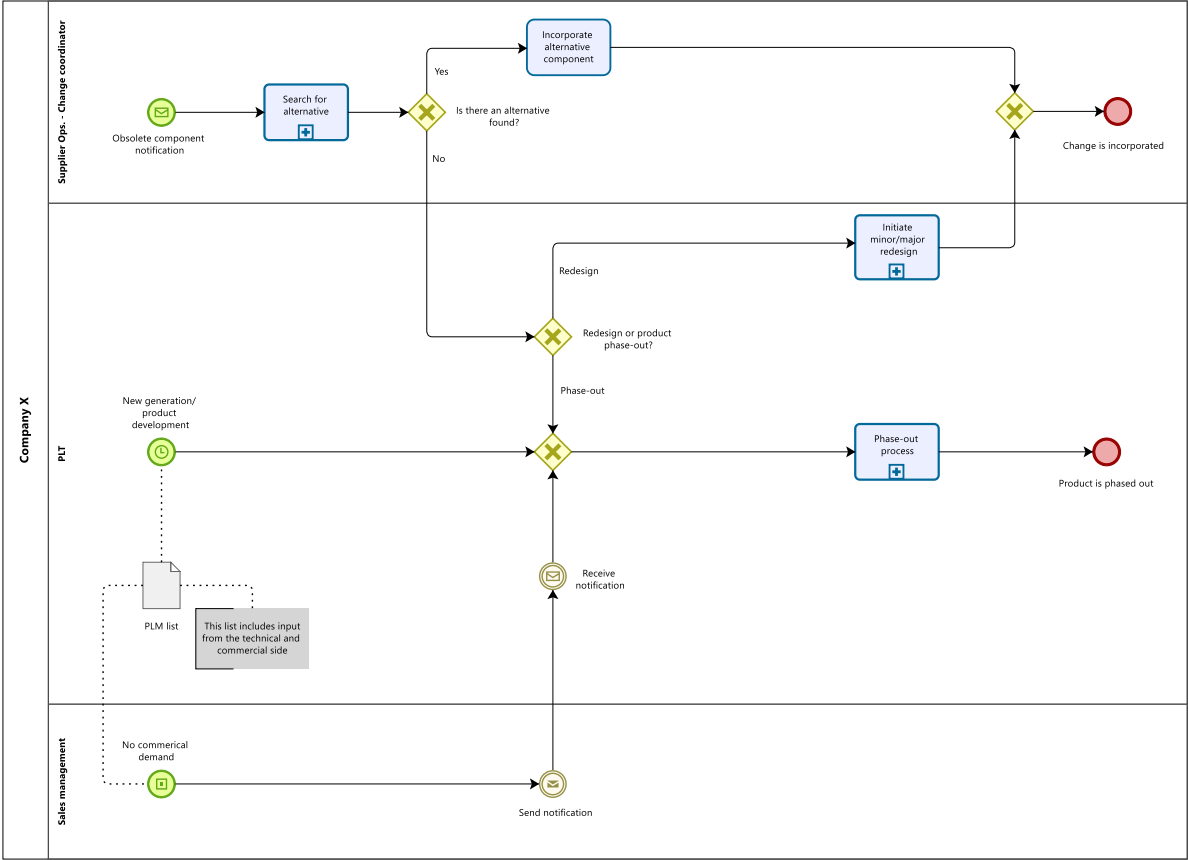
Figure 12 - Triggers for starting a product phase-out

5.2.2 Developed product phase-out

Figure 13 show the developed product phase-out process. After the process is started, the PLT must inform the phase-out team about the phase-out. The phase-out team is a team that does not currently exist within Company X. While evaluating the current and desired situation, it was noted that a role is missing. Namely, the coordinating role, the role that takes the lead in the process. The *process owner*, explained in section 2.2.1, should be part of this team. Throughout the process, it will be seen that the information is always put out from this phase-out team lane and also keeps coming back into this lane.

Figure 13 - Product phase-out process

Once the phase-out team has received the notification, the coordination of the impact assessment can begin. This is a sub-process that will be explained in more detail below. The information gathered in this sub-process should serve as input for MSM in preparing the phase-out plan. It is then the job of the MSM team to prepare a phase-out plan, to slice the plan and then send it to the CLT. The CLT is responsible for assessing and approv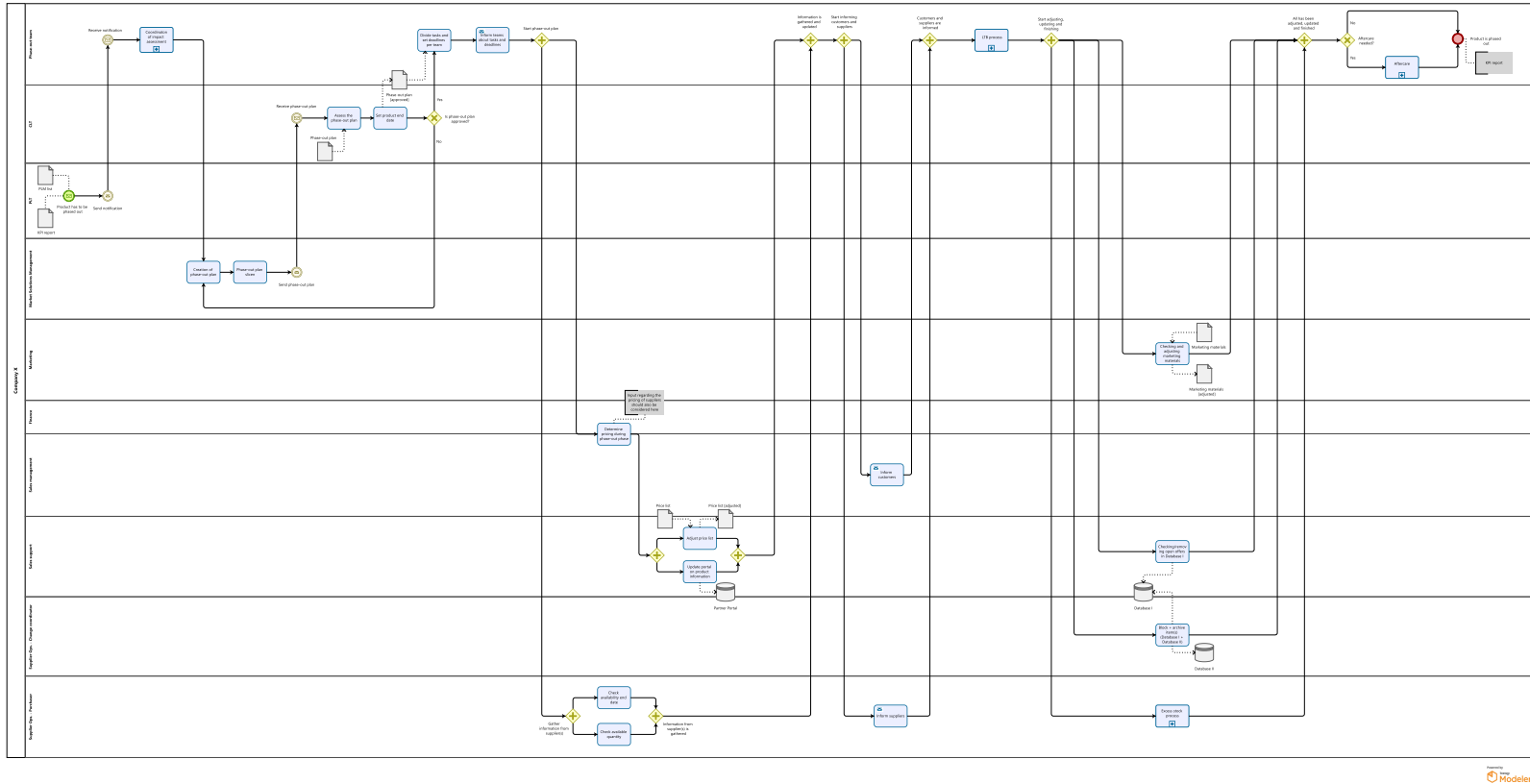ing the phase-out plan and determining the final date when the product must be phased out. If the plan is approved it is sent to the phase-out team, if this plan is not approved it will be sent back to the MSM team again. The phase-out team is in charge of assigning tasks and setting deadlines based on the phase-out plan. They are responsible for sharing the phase-out plan, tasks and deadlines with all the involved parties.

Once this is done, implementation of the phase-out plan can begin. This is done through a number of parallel activities. Sales management and finance have to determine the pricing during the phase-out. Sales support must then adjust these in the price list and they must update the Partner Portal on product information. At the same time, the supplier operations team has to obtain availability information from the suppliers.

The phase-out team is responsible for checking that all these activities have been performed and for collecting all the information. Only when all sequence flows have arrived at the gateway the next step may be performed. This next step is to inform both customers and suppliers of the phase-out of a particular product, component or item series that is of interest to them. Once both sales management and supplier operations have notified their customers and suppliers, the phase-out team can initiate the Last Time Buy (LTB) process. The LTB process is a sub-process and will be explained in more detail below.

After closing the LTB order, the phase-out team must initiate a number of parallel activities. These are adjusting marketing materials, checking and removing open offers in   (order system), archiving and blocking the items in   and   and handling excess stock. The latter is a sub-process, which will be explained in detail below.

In principle, all activities have now been completed and the product has been phased out. However, it may happen that aftercare is needed. This sub-process is explained in more detail below.

5.2.2.1 Sub-processes

In Figure 14, the sub-process for the **coordination of the impact assessment** can be found. Here, the phase-out team is responsible for notifying all stakeholders about the phase-out, on the basis of which MSM, Sales Management and Supplier Operations engage in parallel activities to determine the impact of the phase-out. This involves assessing the market impact , customer agreements, customer impact, forecasts, inventory and purchase obligations, and the impact on R&D projects. All this information must then be gathered by the phase-out team, after which the sub-process can be terminated, and the gathered information should be provided as input for the next step: the creation of the phase-out plan.
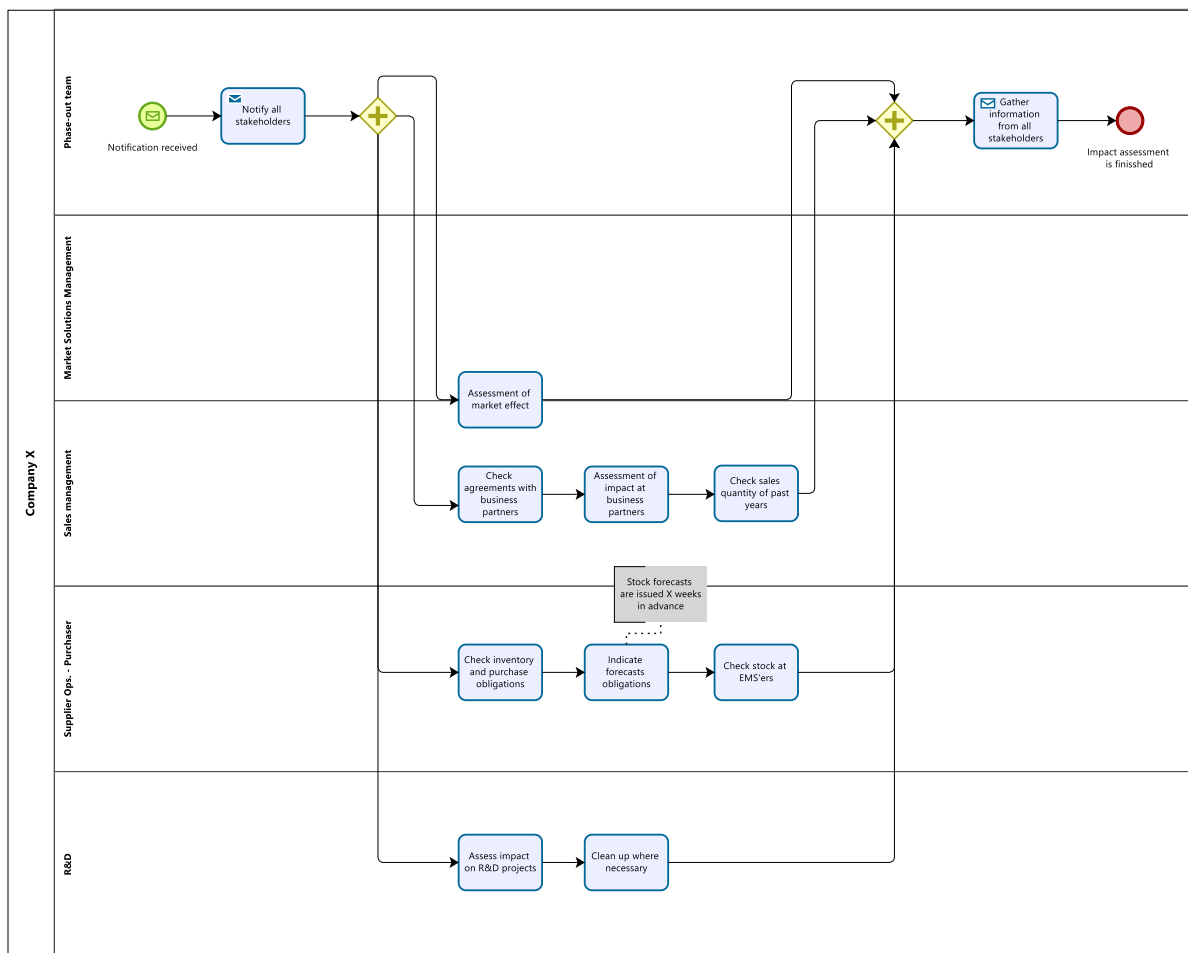

Figure 14 - Coordination of the impact assessment (sub-process)

In Figure 15, the **Last Time Buy (LTB)** sub-process is shown. The LTB process is a sub-process that involves in addition to the Company X swimming pool also the customer, supplier and distributor pools. First, the timing of the LTB must be determined. Then two parallel activities begin, namely sales management that has to check how many spare parts are needed for service and maintenance and the phase-out team that has to determine how much demand there will be for the product that is going to be phased out. Once this is done the sales management and supplier operations team are then given the task of determining the LTB order quantity, order date and delivery date. Both teams send this information to the phase-out team. Once all LTB information is received, the phase-out team can notify all parties involved about it. MSM can then incorporate this information into a newsletter to be sent to all customers. The customers will most likely place an LTB order based on this newsletter. The supplier operations team must place a final production batch with the supplier. The supplier must produce the batch and send it to the distributor. The LTB order will eventually reach the customer via the distributor. This customer will not send a direct message but through a signal the phase-out team should note that the LTB has been completed and that the LTB process can be closed.
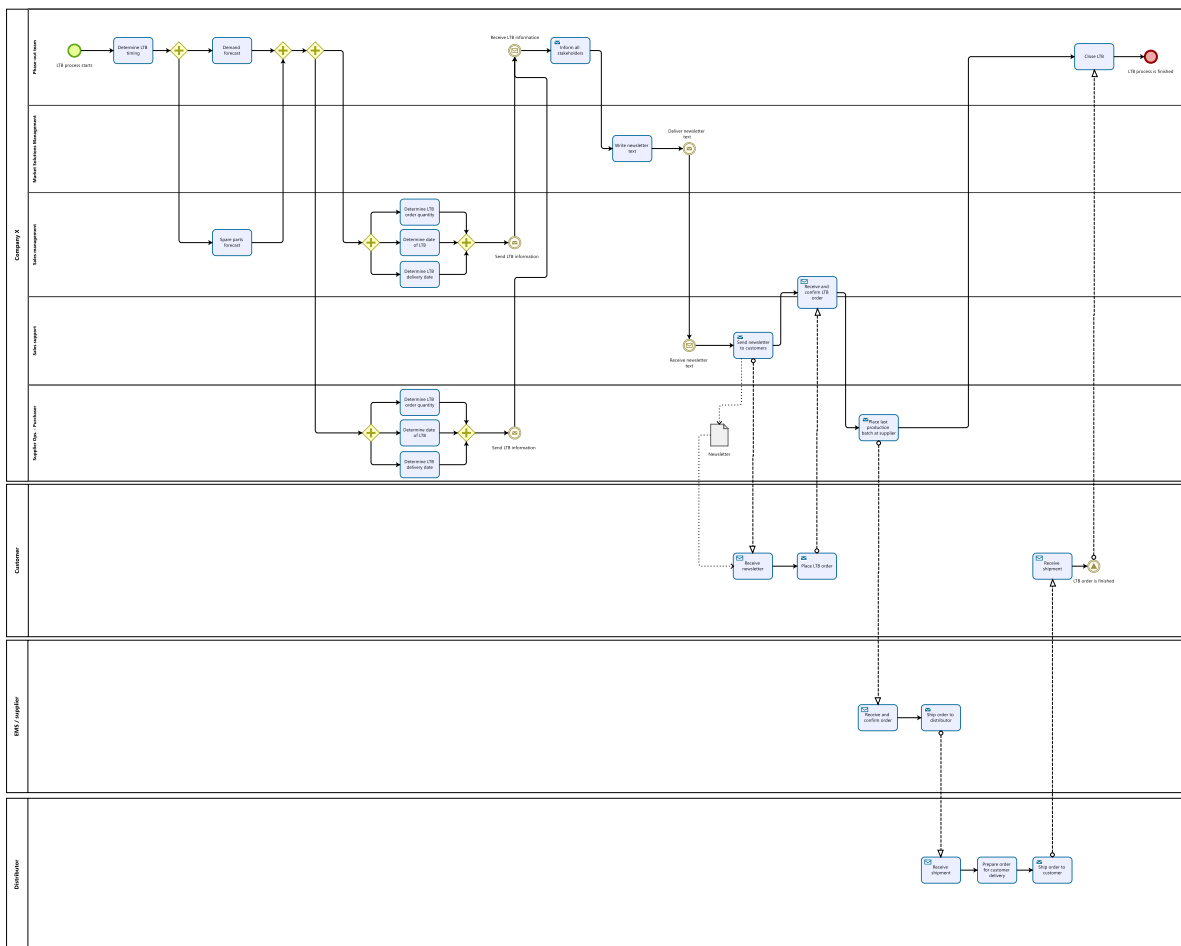
Figure 15 - Last Time Buy (sub-process)

In Figure 16, the **excess stock** sub-process can be found. The aim of this process is to create as much value as possible from the excess stock. For example, the excess stock that is still at an EMS can be used for other products, other business units, or for service and maintenance within Company X. It can also be used within the EMS itself, by another EMS, or it can be sold to external parties, on the aftermarket, or to customers. In cases where no value can be extracted from the excess stock, it must be destroyed. Once the excess stock has been dealt with and the costs involved are calculated, the excess stock sub-process can be terminated.
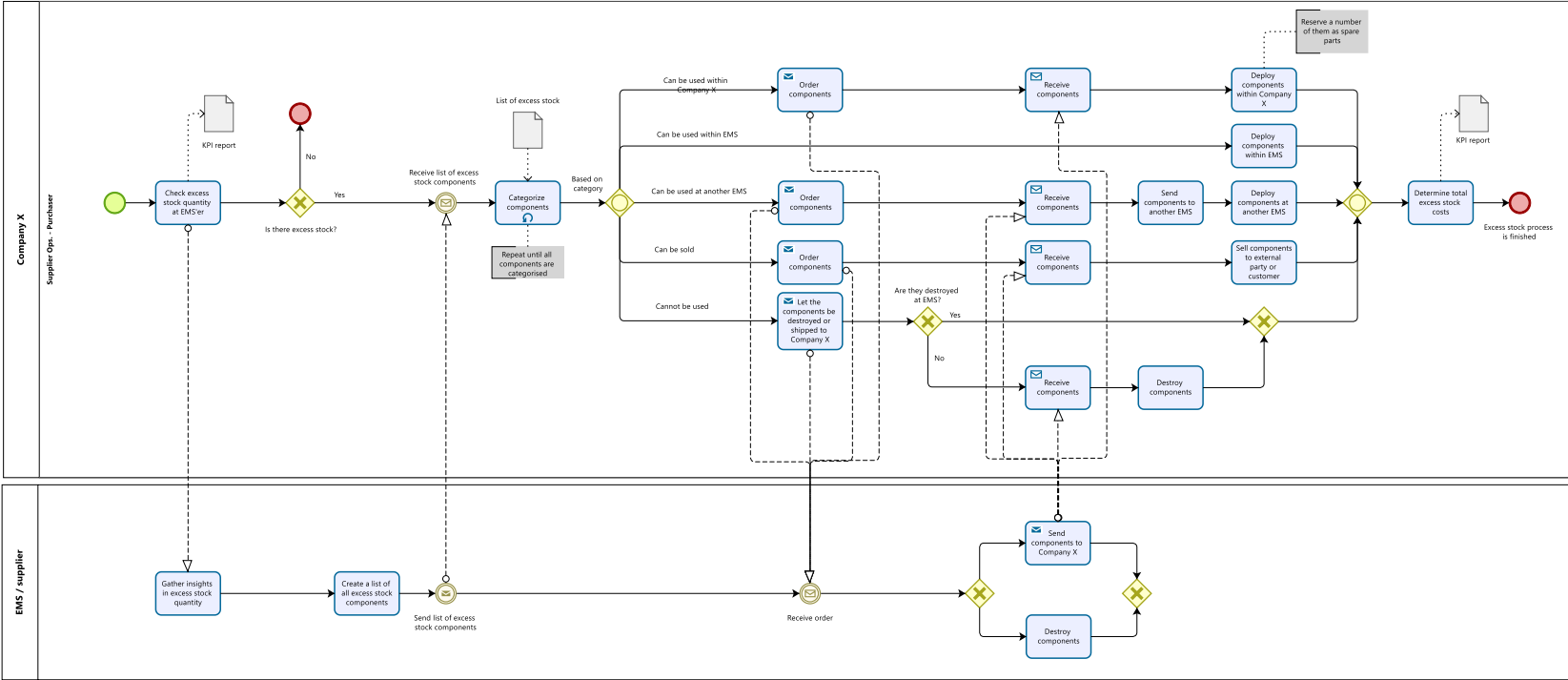
Figure 16 - Excess stock (sub-process)

The **aftercare** subprocess is shown in Figure 17. There may still be agreements with customers about warranty, products still need to be maintained and serviced, or customers may still have questions. In addition, R&D must continue to support the products with software. This process can go on for years, depending on agreements with customers.
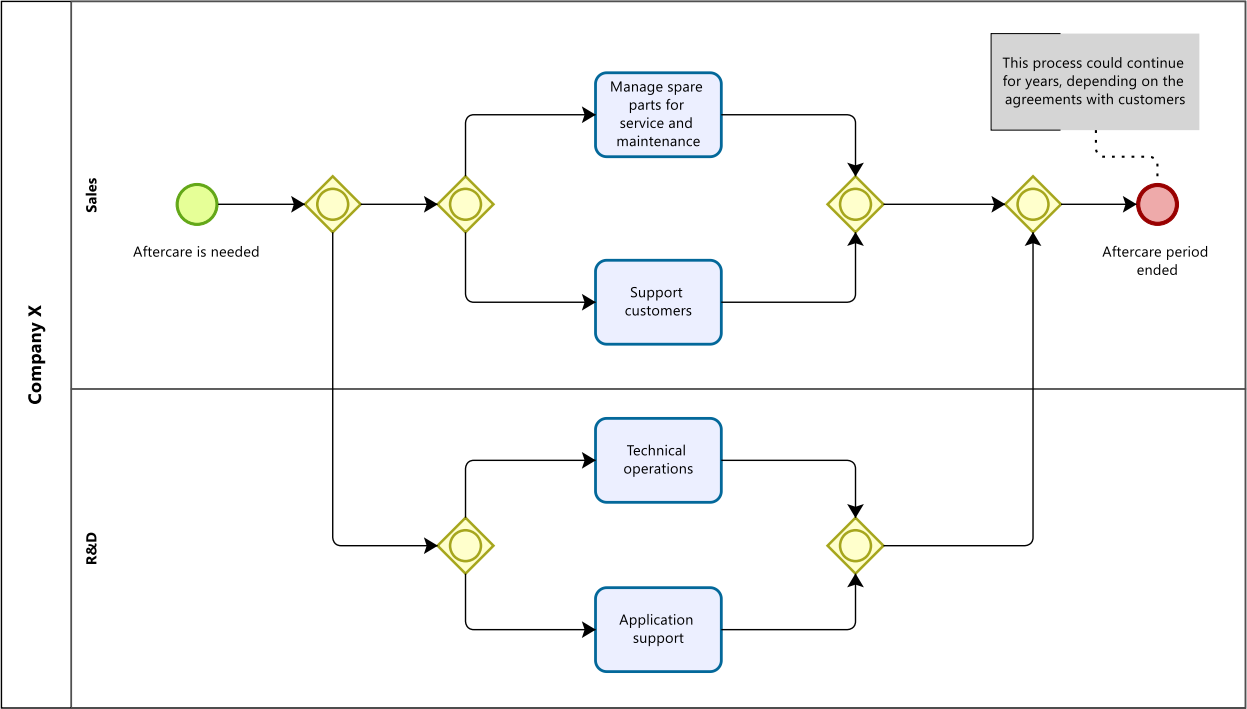
Figure 17 - Aftercare (sub-process)

5.3 Key Performance Indicators (KPIs)

To measure and monitor the performance of the product phase-out process, KPIs can be used. By reviewing and evaluating KPIs Company X can determine whether or not they are hitting their desired objectives in terms of the product phase-out. The following KPIs can be used to measure the performance of the product phase-out process:

- **Excess Stock Quantity:** the amount of excess stock
- **Costs:** the total costs due to incorrect stock estimates
- **Time-to-Phase-Out:** the time that it takes to phase-out a product or component
- **Customer Satisfaction**: the extent to which customers are satisfied with the product phase-out
- **Communication Effectiveness**: the extent to which stakeholders are informed and remain informed during the phase-out process
- **Employee Awareness**: The extent to which employees are aware of the procedures surrounding product phase-outs
- **Percentage of Unplanned Product Phase-Outs**: the percentage of product phase-outs that occur unplanned.
- **Stakeholders Engagement**: the extent to which stakeholders are involved and working together.
- **Total Number of Products in Portfolio**: The total number of active products in the product portfolio

5.3.1 How to measure the KPIs within the established product phase-out process?

At certain activities where the KPIs can be measured and documented an output document is shown in in the decision-making model from Section 5.2. These output documents are called *KPI report* and are depicted as shown in Figure 18.

Figure 18 - Output document 'KPI report'

Not all KPIs can be measured by one specific activity or action. Below, a definition and measurement method will be discussed for all KPIs. The frequency of almost all KPIs is once per phase-out process.

5.3.1.1 Excess Stock Quantity

The Excess Stock Quantity KPI can be defined as the number of products or components that are excess after the LTB closes. This KPI can be measured within the excess stock sub-process. Within this sub-process, the excess stock quantity is checked at the first activity, see Figure 19.

The excess stock quantity can be calculated using the following formula:

$$Excess\ Stock\ Quantity = Stock\ Quantity\ after\ LTB\ closure - Optimal\ Stock\ Quantity$$

Where the optimal stock quantity will be zero in most cases. The more proactive the product phase-out process is, the more gradually products or components can be phased out and the less excess stock there should be. ***The goal is to minimize the excess stock quantity***.
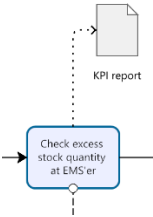
Figure 19 - Measure and document the Excess Stock Quantity

5.3.1.2 Costs

The costs KPI can be defined as the total costs associated with the phase-out process, this includes the excess stock costs and the costs due to shortages. The excess stock cost can be determined in the excess stock sub-process and should be measured and documented during the activity shown in Figure 20. The excess stock costs depend on the excess stock quantity and how this excess stock is handled. The more value is extracted from the excess stock the lower the cost will be. The excess stock cost can be calculated using the following formula:

$$Excess\ Stock\ Costs = Inventory\ Costs + Destruction\ Costs - Salvage\ Value$$

The inventory costs are the costs involved in keeping the products or components in stock. The destruction costs are the costs of destroying the excess stock and the salvage value is the value that can still be generated from the products or components.

Then there are the costs that arise in case of shortages. These are the extra cost of having to buy at the aftermarket or the higher cost at the supplier. These costs can be calculated using the following formula:

$$Shortage\ Costs = Quantity\ Short * Extra\ Costs\ per\ Unit$$

Total cost can be determined by summing the excess stock and shortage costs. ***The goal is to minimize total cost.***

$$Total\ Costs = Excess\ Stock\ Costs + Shortage\ Costs$$

Figure 20 - Measure and document the Excess Stock Costs

5.3.1.3 Time-to-Phase-Out

Time-to-phase-out refers to the time it takes to phase out a product. This refers to the period between the moment it is determined that a product will be phased out and the moment the product is completely phased out. The following formula can be used to determine the duration of the phase-out:
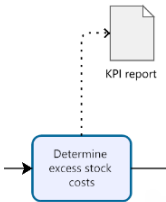
$$Time\ to\ Phase\ Out = Completion\ Date - Starting\ Date$$

Within the established decision-making model, the KPI can be measured by taking the period between the start event (starting date) and the end event (completion date), see Figure 21. By looking only at this KPI and how long or short a phase-out takes, it is not necessarily possible to determine if a phase-out process is going well. If proactive action is taken and the phase-out is announced two to three years in advance, the process will take much longer than if an unplanned obsolete component is identified. ***This KPI is mainly helpful in determining the average time a phase-out takes, this can be used as a benchmark and can be considered by Company X when making choices and plans in the future.***
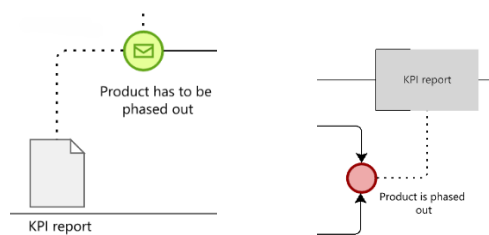
Figure 21 - Start- and end event of the product phase-out process

5.3.1.4 Customer Satisfaction

Customer satisfaction can be measured using the Customer Satisfaction Index (CSI). The CSI is a metric used to measure the level of customer satisfaction with an organization or a specific product or service (Thomas, 2024).

At the end of a phase-out process, customers should be asked how satisfied they are with the course of the phase-out. This can be done using a survey or a standard form can be completed during a meeting between the customer and Company X. This survey or format should include the customer satisfaction factors from section 4.2.2: timing of communication, quality of information, reliability of information and successor costs. Customers must rank these customer satisfaction factors using a Likert scale from one to five. One is the lowest score, very dissatisfied, and five is the highest score, very satisfied. In case the phase-out involves multiple customers, the average scores for each customer satisfaction factor should be calculated and the overall CSI can be determined using the following formula:

$$Customer\ Satisfaction\ Index = \frac{\sum Averages\ score\ of\ each\ customer\ satisfaction\ factor}{Total\ number\ of\ customer\ satisfaction\ factors}$$

The higher the CSI the higher the customer satisfaction. Thus, ***the goal is to maximize the CSI***.

In addition to measuring CSI per phase-out, assessing customer satisfaction helps Company X correct errors from one product phase-out process to another. By soliciting customer input and

learning from past experiences, Company X can continuously improve the process and thus increase the quality over time.

5.3.1.5 Communication Effectiveness

In the BPMN model, message events and sending and receiving tasks are used, as shown in Figure 22. Communication effectiveness can be measured by these events and activities. On this basis, it is possible to monitor whether all events and activities took place, whether the messages were actually sent and received by the right participants, and whether the messages were sent at the right point in time.

The use of effective communication channels also plays a major role in measuring and increasing communication effectiveness. For example, e-mail, phone calls, letters or face-to-face communication can be used. By integrating the use of communication channels into the decision-making model and regularly measuring their effectiveness, bottle necks and areas for improvement can be identified. It is important that all stakeholders are aware of the communication channels used and how they can be used. Finally, a communication matrix can be used to increase communication effectiveness.

Figure 22 - Message events and sending and receiving tasks

5.3.1.6 Employee Awareness

The Employee Awareness KPI aims to measure and monitor the extent to which employees are aware of the procedures surrounding the phasing out process. It refers to how well employees know what they are supposed to do and understand the objectives. To increase employee awareness, it is important that employees are well trained, processes and procedures are clearly documented and that regular updates are given as changes occur. Employees should be able to understand these changes and adapt to them correctly. The goal is to maximize the employee awareness.

There are different methods that can be used to measure the employee awareness. It can be measured by measuring and monitoring the participation rate during training sessions or workshops related to the phase-out. This can be calculated as follows:

$$Participation\ Rate = \left(\frac{Number\ of\ Participating\ Employees}{Total\ Number\ of\ Employees\ Expected} \right)$$

Besides the participation rate, the frequency that employees participate is important.

In addition, measuring the completion rate of activities in the phase-out process can help determine employee awareness. This can be calculated as follows:

$$Completion\ Rate\ of\ Activities = \left(\frac{Number\ of\ Completed\ Activities}{Total\ Number\ of\ Activities}\right)$$

Whether decisions (XOR gateways) are made in the right way is also indicative of Employee Awareness, the more aware employees are of the process, goals and impact, the better decisions can be made. The number of times the process thus returns to an earlier point (redoing work) due to wrong decisions can give an indication. The smaller this number is, the higher the employee awareness.

There is no formula to calculate the overall level of employee awareness. Thus, this KPI must be measured based on an aggregate reflection of the participation rate, completion rate and number of repetitions in the process. ***The goal is to maximize the participation rate and completion rate, ideally to a score of 1, while minimizing the number of repetitions in the process.***

5.3.1.7 Percentage of Unplanned Product Phase-Outs

This KPI can be defined as the percentage of product phase-outs that occur unplanned in relation to the total number of product phase-outs. The following formula can be used to calculate this percentage:

$$Percentage\ of\ Unplanned\ Product\ Phase\ outs = \left(\frac{Number\ of\ Unplanned\ Phase\ outs}{Total\ Number\ of\ Phase\ out}\right) * 100$$

The current process waits for a reactive trigger, that a component is no longer available and therefore a product is no longer producible. On that basis, it must then be decided that a product should be phased out. In the improved process, proactive action should be taken and phase-outs will be scheduled in advance. The KPI measures how many product phase-outs are based on unplanned/reactive triggers and how many product phase-outs are planned and thus proactive.

As shown in Figure 23, this KPI should be measured and documented at the start of the process. This is where the trigger for starting the phase-out process should be indicated. ***The goal is to minimize the percentage of unplanned phase- outs and thus mitigate risks.***
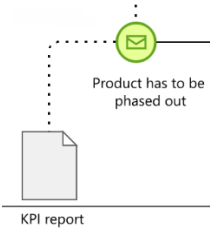

Product has to be phased out

KPI report

Figure 23 - Note the product phase-out trigger

5.3.1.8 Stakeholder Engagement

The Stakeholder Engagement KPI measures the extent to which stakeholders (employees, business partners and suppliers) are involved and working together during the phase-out process.

From the side of business partners and suppliers, it is important to involve them as early as possible but also to provide them with relevant and detailed information. So, the challenge is to balance early communication with relevant and detailed information. Once the required information is gathered, it is key to involve the external stakeholders in the process as soon as possible. ***The goal is to minimize the period (D_i - D_c) between the date that all required information is collected (D_c) and the date that the stakeholders are involved (D_i).***

In the established model there are several tasks (gateways, events and activities) to ensure that stakeholders are continuously involved and informed about the process. For informing and involving the internal stakeholders, the responsibility lies with the phase-out team. The completion rate of these coordinating tasks, the tasks of the phase-out team, can be used to measure internal stakeholder engagement. This can be done as follows:

$$Completion\ Rate\ of\ Coordinating\ Tasks = \left(\frac{Number\ of\ Completed\ Tasks}{Total\ Number\ of\ Tasks} \right)$$

The goal is to achieve the highest possible rate, ideally a rate of 1.

5.3.1.9 Total Number of Products in Portfolio

This KPI can be described as the total number of active products in the product portfolio. Active products refer to those currently available for sale. The following formula can be used for this:

$$Total\ Number\ of\ Products\ in\ Portfolio = \sum All\ active\ products$$

A smaller product portfolio provides a clearer overview and allows for tighter and more efficient processes. It also helps in reducing costs related to inventory management, production and marketing, while enhancing overall product quality. This KPI should be measured after the product portfolio review, that should be conducted every six months. By using this KPI, Company X can measure, compare and align the number of products with its strategic goals.

The current objective is to reduce the number of products to reduce complexity and gain deeper insights into Product Lifecycle Management (PLM). *As* new product generations are introduced, older ones should be phased out accordingly. However, the strategic focus of this KPI may evolve in the future. Company X might seek to expand its market reach or attract more customers by introducing new products.

5.3.2   The KPIs and their relationships

In Figure 24, the relationships between the KPIs are visualized. A positive relationship is shown with a plus symbol, meaning that if one KPI increases/decreases, the related KPI also increases/decreases. A negative relationship is represented with a minus symbol, meaning that if one KPI increases/decreases, the related KPI does the opposite.
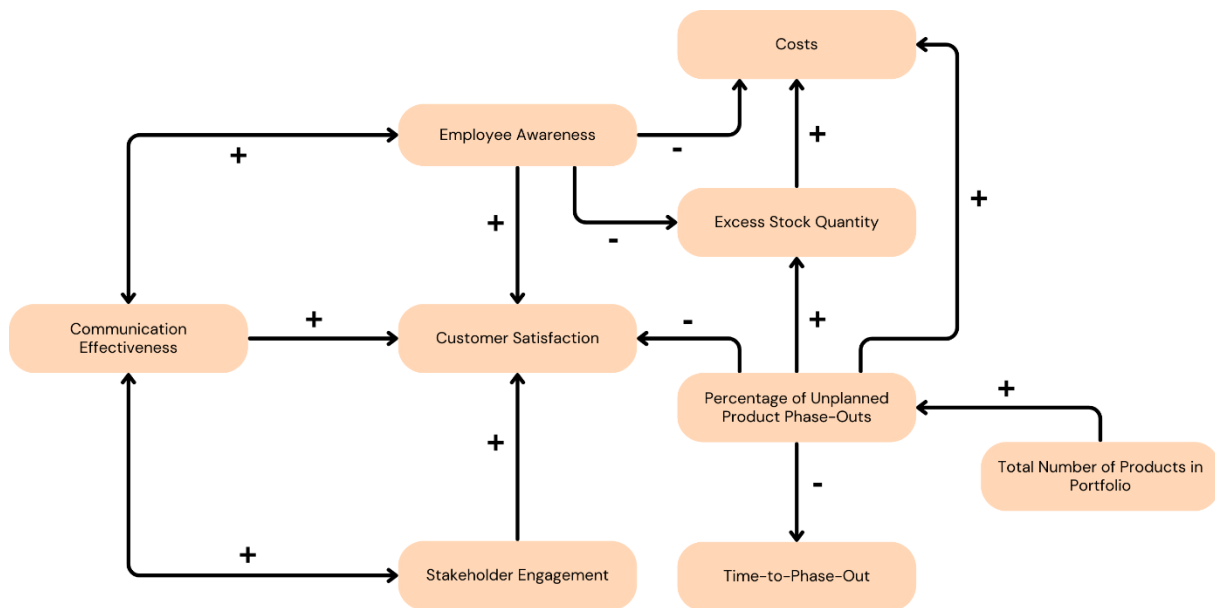
Figure 24 - The KPIs and their relationships

Starting on the right: the total number of products in the portfolio has a **positive** impact on the percentage of unplanned product phase-outs. When the number of products in the list decreases, complexity decreases and PLM insights improve, leading to a decrease in unplanned product phase-outs.

An increase in the percentage of unplanned product phase-outs has a **positive** relationship with the excess stock quantity; it will therefore increase. This is because in an unplanned phase-out, the process is not gradual. In addition, there is a **negative** relationship with the time to phase-out. A decrease in the percentage of unplanned phase-outs, leads to an increase in the time to phase-out products, as there is more time to plan and manage the phase-out. Moreover, a high rate of unplanned product phase-outs will lead to lower customer satisfaction (**negative** relationship), as identified earlier in this study, as customers like to be informed in a timely manner.

The amount of excess inventory has a **positive** relationship with cost. The more excess stock, the higher the inventory cost and hence the total cost. Furthermore, employee awareness has a **negative** relationship with costs. Well-informed employees can perform their tasks better, make better forecasting estimates and this will lead to lower costs. In addition, well-informed employees deliver better quality, which increases customer satisfaction (**positive** relationship). If employees know exactly what to do, communication will also improve and vice versa (**positive** relationship).

Finally, stakeholder engagement. If stakeholders are better engaged in the process, they will also be able to communicate better and vice versa (**positive** relationship). Stakeholders also include customers. So stakeholder engagement has a **positive** relationship with customer satisfaction.

5.4 Risks assessment

In this section, a risk assessment is conducted to identify, evaluate and manage potential risks. Priorities are determined using a priority matrix, mitigation strategies are presented, and to assist in monitoring and evaluation, risks will be linked to KPIs.

The phase-out process involves various risks. Risk, according to Becker (2004), can be defined as "an uncertain event or condition, that if it occurs, has a positive or negative effect on a project objective". Thus, a risk is an event that has a chance of occurring but has not yet occurred or will not always occur (probability < 1). It can have both negative and positive impacts on the objective. In Section 3.4 a SWOT analysis is performed to identify the strengths, opportunities, weaknesses and threats of the phase-out process within Company X. This SWOT analysis is used to reveal positive forces that work together and potential problems that need to be recognized and possibly addressed (Renault, n.d.). Based on these weaknesses and threats and further analysis of the potential risks, the following list of risks can be identified.

Financial risks (risks related to higher costs due to incorrect stock estimates)

- Higher costs due to shortages
    - o Requiring aftermarket purchases or incurring higher supplier costs
- Higher costs due to surplus
    - o Inventory costs or wasted costs

Operational risks (risks related to inefficient operational processes)

- Delays or issues due to ineffective communication
- Data fragmentation or a lack of data due to ineffective information flows
- Failure to perform activities properly due to low employee awareness
- Low stakeholder commitment due to poor engagement

Customer satisfaction risks (risks related to customer satisfaction)

- Decrease in customer satisfaction due to product unavailability, lack of communication and information and higher prices can lead to:
    - o Loss of trust
    - o Bad reputation
    - o Deterioration of relationships
    - o Decline in sales

Portfolio management risks (risks associated with managing the product portfolio)

- The larger the portfolio, the more complexity challenges
- Poor portfolio management can lead to lack of insights into the PLM
- Poor portfolio management can lead to the occurrence of more unplanned (reactive) phase-outs

After the risks have been identified, it is important to prioritize the risks. According to Minsky (2016), "Risk prioritization is the process of determining which risk should be acted upon first. This should be based on the likelihood of a risk and the impact it would make." To support this evaluation, the Risk Priority Matrix shown in Figure 25 is created. Herein, the impact of risks is weighted more heavily than the likelihood that a risk will occur. A risk with medium likelihood but high impact is prioritized as high, while a risk with high likelihood but medium impact is prioritized as medium.
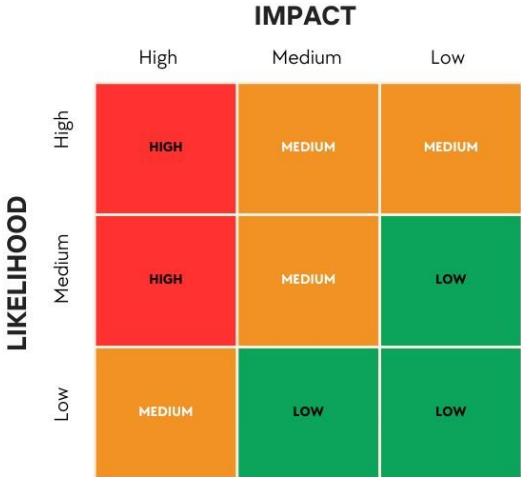

Figure 25 - Risk Priority Matrix

Table 2 shows an overview of the risk assessment. It contains the risk category and a description. In addition, the likelihood of the risk occurring and the impact the risk would have are ranked 'low', 'medium' and 'high'. The priority is based on the Risk Priority Matrix. Finally, strategies that can be used to mitigate the risks are listed.

Risk category	Risk description	Likelihood	Impact	Priority	Mitigation strategy
Financial risks	Higher costs due to incorrect stock estimates	**High**	**High**	**High**	Monitor inventory levels regularly and adjust if needed. In case of shortages go through the change management process. If there is a surplus run through the excess stock sub-process.
Operational risks	Delays or issues due to ineffective communication	**Medium**	**Medium**	**Medium**	Use a communication matrix or protocol and set clear deadlines.
	Data fragmentation or a lack of data due to ineffective information flows	**Medium**	**High**	**High**	Use central databases, standardized process flows and consistent information exchange.
	Failure to perform activities properly due to low employee awareness	**Medium**	**Medium**	**Medium**	Train employees, provide documentation and provide regular updates as processes or procedures change.
	Low stakeholder commitment due to poor engagement	**Medium**	**Medium**	**Medium**	Ensure that stakeholders are involved early in the process and also keep them actively informed.
Customer satisfaction risks	Decrease in customer satisfaction	**Medium**	**High**	**High**	Communication is key. Communicate early and with detailed information. Make clear agreements

					and set expectations.
Portfolio management risks	Complexity associated with managing a large product portfolio	**High**	**Medium**	**Medium**	Evaluate and optimize the portfolio in a frequent manner and based on clear preconditions.
	Lack of insight into the PLM	**Medium**	**Medium**	**Medium**	Introduce advanced PLM systems or tools for a clear overview.
	The occurrence of unplanned (reactive) phase-outs	**Medium**	**High**	**High**	The phase-out process should be structured, well-documented and proactive, this can be achieved through clear agreements and well-organized processes.

Table 2 - Risk Assessment

The identified risks can thus be ranked either as high priority or medium priority. Figure 26 shows a summary, how many risks were rated with what priority. The high priority risks are mainly financial risks and those related to customer satisfaction. Medium priority risks are mainly those related to internal processes.

High priority means that there is a high impact and a high probability of a risk occurring. These risks require immediate attention and action. Medium priority are those risks with medium impact. These are the risks that require monitoring and consideration but do not require immediate action. Low priority risks are those with low impact and medium to low probability. These risks require less frequent monitoring and also do not require immediate actions.

IMPACT

<table>
<tr><th></th><th></th><th>High</th><th>Medium</th><th>Low</th></tr>
<tr><td rowspan="3">LIKELIHOOD</td><td>High</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>Medium</td><td>3</td><td>4</td><td>0</td></tr>
<tr><td>Low</td><td>0</td><td>0</td><td>0</td></tr>
</table>

Figure 26 - Risk Assessment Summary

As a final step, Table 3 lists the risks by category and the KPIs associated with them. This is to make monitoring, evaluating and managing the risks more transparent, objective and efficient.

Risk category	Associated KPIs
Financial risks	- Costs - Excess Stock Quantity
Operational risks	- Time-to-Phase-Out - Communication Effectiveness - Employee awareness - Stakeholder Engagement
Customer satisfaction risks	- Customer satisfaction
Portfolio management risks	- Total Number of Products in Portfolio - Percentage of Unplanned Phase-Outs

Table 3 - Risks with associated KPIs

5.5 Validation

Several steps were taken during the research to validate information and the results. Information was gathered through qualitative data gathering methods. Through workshops, employees were asked to identify current and desired processes and during individual interviews, additional or more detailed information was requested. After each workshop, a summary or overview of the collected insights was provided to the stakeholders, which also served as a starting point for the next workshop. After establishing the decision model, the involved parties were asked if they had any feedback or improvements, this was requested during multiple validation meetings with representatives from each team. The interview questions sent to the suppliers and business partners were first sent to my supervisor at Company X to verify that they were going to measure what they were supposed to measure. There was also a validation meeting with my supervisor at the company where we discussed the decision-making model and went over the report and risk assessment.

Finally, a survey was sent to the participants of the workshops. These are the internal primary stakeholders. The survey is used to validate whether the research has actually contributed to optimizing the phase-out process. The survey asks whether the decision-making model contributes to making the phase-out process more structured and proactive, reducing risks and maintaining or increasing customer satisfaction. The survey can be found in Appendix F.

Seven of the eight participants completed the survey. The first section of the survey focused on the developed decision-making model and the established KPIs. In this section, seven Likert scale questions were asked to measure respondents' level of agreement or satisfaction with certain statements. The questions included both positive and negative statements, where respondents were asked to rate their answers on a scale from 1 (" Strongly Disagree") to 5 ("Strongly Agree"). Mean scores for all Likert scale questions can be found in Appendix G. The positive statements of this section received an average score of 4.5, while the negative statements received an average score of 1.8. This indicates that respondents were generally satisfied with the decision-making model. In addition, respondents rated the statement saying that the overall model made the phase-out process more structured and well documented with a mean score of 5, the highest possible score. This first section concluded with an open-ended question where respondents had the opportunity to comment on the KPIs. The responses to this open-ended question are included in Appendix G.

The second section of the survey focused on the extent to which the survey results, recommendations and model contribute to increasing customer satisfaction and reducing risk. Again, respondents were asked to rate statements using a Likert scale, only positive statements were used to avoid confusion. All mean scores in this section were above 3, indicating that most respondents agreed with the statements and that in their opinion the survey contributes to increasing customer satisfaction and mitigating risks.

In the final section, respondents filled out a Likert scale to rate whether the overall research findings led to a more proactive approach to the phase-out process and whether the research findings were too complex and time-consuming. The first statement was rated with an average score of 4.9, while the second statement received an average score of 1.6. This is a preferable outcome. Finally, respondents were given the opportunity to make any further positive or negative remarks, with all of the remarks submitted being positive. These comments can be found in Appendix G as well. Overall, the outcome of the survey is very positive and shows that, according to Company X employees, the research actually helped to improve the product phase-out process.

6 Conclusion and recommendations

This is the final chapter, in which recommendations are made for the implementation of the research findings, and final conclusions and recommendations will be drawn to answer the main research question: *"How can Company X effectively organize its decision-making process within the product phase-out stage to minimize (financial) risks without compromising on customer satisfaction?"*

During the problem identification, it emerged that Company X needs to transition from an unstructured and undefined phase-out process to a structured and well-documented phase-out process to overcome related problems such as unclear responsibilities, process inefficiency, and lack of clear communication and information. The absence of a clear decision-making model was defined as the core problem. The research aimed to reduce risks, control costs, increase process efficiency, and maintain customer satisfaction as a result of an optimized decision-making model.

In the second chapter, a literature review was conducted to support the research with standard techniques and concepts. It addressed the research question: *"What are existing/standard decision-making models and frameworks used during product phase-out and for modelling business processes?"*. The review provided foundational insights into analysing, managing, and modelling the phase-out process. It explained the product lifecycle, defined the product phase-out, and investigated analysis methods like stakeholder analysis and gap-analysis. Insights from the BPM lifecycle served as fundamental components for subsequent chapters. Additionally, the review described how Business Process Modelling Notation (BPMN) is used to prepare business process models.

In the third chapter, the current situation was mapped, and a stakeholder analysis and SWOT analysis were conducted to address the research questions: *"What are the current stakeholders and steps in the product phase-out process?"* and *"What are the key risks and opportunities associated with the product phase-out at Company X, and how are these currently identified and assessed?"*. The data used in this chapter were obtained from several workshops and interviews, which mapped the current steps of the phase-out process and identified inefficiencies and points for improvement. A stakeholder analysis was conducted to identify key teams and parties involved in the phase-out process, such as the primary stakeholders MSM, Sales, Operations, and R&D. The various triggers for initiating a phase-out were identified, with obsolete component notification being the trigger in nine out of ten cases. Company X employs methods to reduce risks and identify obsolete components in advance, but these methods are not implemented proactively. Additionally, there are currently no guidelines, protocols, or procedures in place to ensure the phase-out process runs smoothly. A SWOT analysis revealed weaknesses, strengths, threats, and opportunities, which were used to identify risks and highlight the need of this study.

In the fourth chapter, a benchmarking study was conducted, and customer satisfaction factors were identified, addressing the research questions: *"How are other business units within Company X (BU 2, BU 3, BU 4 and BU 5) handling this problem?, "How do suppliers and customers view the product phase-out process and what are specific guidelines or expectations from them?"* and *"How can maintaining or improving customer satisfaction be effectively integrated into the product phase-out decision-making model?"*. Interviews with representatives from other business units revealed that their phase-out processes are much more proactive, the obsolete component notification is only the trigger in one out of 10 cases, and phase-outs are announced more than two or three years in advance, allowing products to be phased out gradually. Recommendations derived from the benchmark study include conducting semi-annual meetings, optimizing the product portfolio, assigning a process owner, knowing about the lifespan of products, taking a long-term perspective and maximizing the use of excess stock.

Additionally, customer interviews highlighted the need for early communication and clear information. The identified customer satisfaction factors include timing of communication, follow-up costs, quality of the information and reliability of information. According to customers, timely communication is the most crucial factor: the earlier the communication, the better. They indicated that establishing a communication matrix would be useful, that they would like to have a dashboard containing the latest updates on product lifecycles and that an overlapping period, with both the new and old version on sale, would help them facilitate a smooth transition.

Chapter 5 addressed the research question *"How can an effective decision-making model be developed for the product phase-out at Company X, incorporating (financial) risk management?"* by developing an enhanced product phase-out process and conducting a risk assessment. The developed business process model introduced a team that currently does not exist within Company X but is crucial for coordinating the phase-out process efficiently. his is the phase-out team, which is responsible in the process for coordinating, keeping everyone informed and taking the lead. Several KPIs were established to help Company X monitor and measure the performance of product phase-outs. In addition, a risk assessment was conducted to identify various risks associated with the phase-out process and to propose strategies to mitigate these risks. The highest priority risks, which have both a high impact and a high probability, are financial risks and risks related to customer satisfaction. Risks with medium priority mainly relate to internal processes.

6.1 Recommendations for implementation

The first recommendation is to form a **phase-out team and assign a process owner.** Based on the established decision-making model, it can be concluded that an essential role in the phase-out process is currently missing: the process owner. The process owner is responsible for running the process efficiently and effectively. It is the initiating and coordinating role and is responsible for planning, organizing and monitoring the process. All parties involved currently perform their own tasks but at the moment of domain overriding tasks or decisions, tasks are not handled. In the decision-making model, a new team is set up: the phase-out team. The phase-out team should consist of representatives from the MSM, Sales, Operations and R&D

domains. Thereby, one person should be designated as the lead, in other words the process owner, which is responsible for efficient coordination across domains.

The second recommendation is to create a **PLM portfolio list**. This list should reflect the life cycle phase of products and the phase-out date of products. The list should be managed by the PLT and they should be responsible to initiate product phase-out based on it. This list should be reviewed, evaluated and updated at a semi-annual meeting based on input from the technical and commercial side.

This leads directly to the third recommendation, which is to schedule a **semi-annual meeting** to review the product portfolio. This meeting should be initiated by the process owner as described above. During this meeting, all teams should come up with input on which products could be phased out in the future, **more than two to three years in advance**. This way Company X can act more proactively and products with critical components, low demand, a newer version or a successor can be phased out before they become obsolete.

The final recommendation is to **start measuring and monitoring the suggested KPIs**. By measuring these KPIs, better insight can be created into the performance of the phase-out process, weaknesses can be exposed and new opportunities can arise. It helps Company X correct errors from one product phase-out process to another.

6.2 Limitations

The study faces several limitations. Firstly, the last two steps of the Management Problem Solving Method (MPSM) approach, involving solution implementation and evaluation, were not executed due to time constraints. Secondly, the research is based solely on qualitative data. Qualitative research provides valuable insights, but its reliance on subjective interpretation and limited sample size, such as only two customer interviews, reduce the overall representativeness and objectivity of the study. In addition, the proposed decision-making model introduces a new team that does not currently exist within Company X. Thus, before the model can be effectively implemented, this team must first be established within the organization.

6.3 Further research

There are several opportunities for improving the study and for starting a follow-up research. First, there is room to refine the Key Performance Indicators (KPIs) used in measuring and monitoring the phase-out process. For example, for the communication effectiveness KPI, detailed information on message channels could be added. In addition, the last two phases of the problem solving approach, the implementing and testing phase, have not been executed. In doing so, it could also be determined whether the KPIs actually reflect the performance of the phase-outs or whether other KPIs should be established. Another possibility for further research is that the current study has focused only on the final phase of the product life cycle, the product phase-out, a follow-up study could also examine the phase-in process and the other phases of the PLM.

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Appendix

Appendix A – Workshops

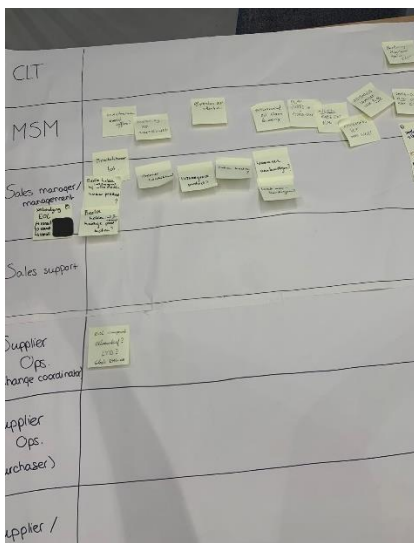*Figure 27 - Workshop set-up for mapping the current and desired situation*

Figure 28 - Current situation mapping

Figure 29 - Matrix used to identify key decisions

Overlapping key decisions		Accountable				Responsible			
		MSM	R&D (hardware)	R&D (software)	Operations	MSM	R&D (hardware)	R&D (software)	Operations
Commercial phase	14 PLM	MSM	MSM	PLT	MSM	PLT	MSM	PLT	PLT
	15 Continue or phase out?	MSM	MSM	-	-	PLT	MSM / R&D / Ops.	-	-
Out phasing	16 Phase out plan	MSM	MSM	-	-	MSM	Sales	-	-
	17 LTB	-	MSM	-	MSM	-	Sales	-	Sales
	18 Phase out decision / timing	MSM	-	-	?	MSM	-	-	Sales
	19 Actual phase out	?	MSM	?	-	?	Sales	PLT	-

Figure 30 - Key decisions results

Figure 31 - Desired situation mapping

CLT
- Based on proactive PLM phase-out list
- EOL trigger from Company X
- Coordination of impact assessment by sales and MSM
- Proposing phase-out plan to CLT
- Testing the decision on how/what
- End date of decision evaluation

MSM
- Assessment of market effect
- Establishing a planning for the new product (if necessary)
- Check if there is a substitute product (link PLT)
- Responsible for creating phase-in and phase-out plan
- Decision on when and what to do (agenda)
- Phase-out plan slicen

Sales manager/management
- EOL trigger from customer
- Check agreements with BP
- Assessment of impact at BP
- Assessment of impact at BP

Sales support

Supplier Ops. – Change coordinator
- EOL trigger Obsolete component

Supplier Ops. – Purchaser
- Conclusion of change management process is that the product should be phased out
- Rreceive notification about EOL trigger
- Stock forecasts are issued 78 weeks in advance
- Check inventory and purchase obligations

Supplier/EMS
- EOL trigger from supplier
- Check stock at EMS'ers

Other
- Conclusion of change management process is that the product should be phased out
- Coordination among all stakeholders and taking responsibility (by whom?)

TRIGGERS — **PLAN AND COORDINATION**

1/2

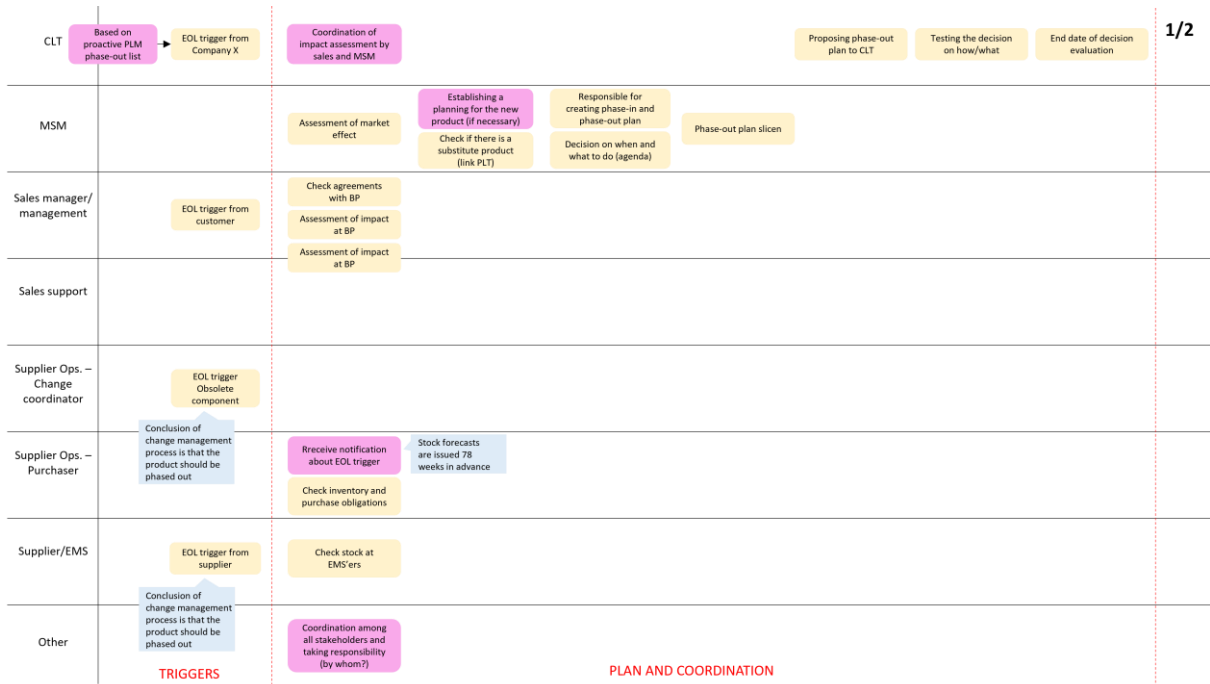*Figure 32 - Results desired situation workshop (page 1/2)*

CLT

MSM
- Delivery of newsletter text
- Checking and adjusting marketing materials

Sales manager/management
- Determine pricing during phase-out phase
- Inform customers
- Check spares
- Determine LTB order quantity
- Determine date of LTB
- Determine when LTB delivery
- Customers place LTB order at Company X
- Closing LTB

Sales support
- Adjust price list
- Portal update (product information)
- Inform customers through the newsletter
- Checking/removing open offers
- Optional 'aftercare'

Supplier Ops. – Change coordinator
- Block + archive item (Database I + II)

Supplier Ops. – Purchaser
- Check availability end date
- Check quantity available
- Inform suppliers
- Determine excess stock costs
- Order excess stock at supplier

Supplier/EMS

Other
- Alignment with domains on phase-out plan (by whom?)
- Check demand + timing (by whom?)
- Coordinate LTB (by whom?)
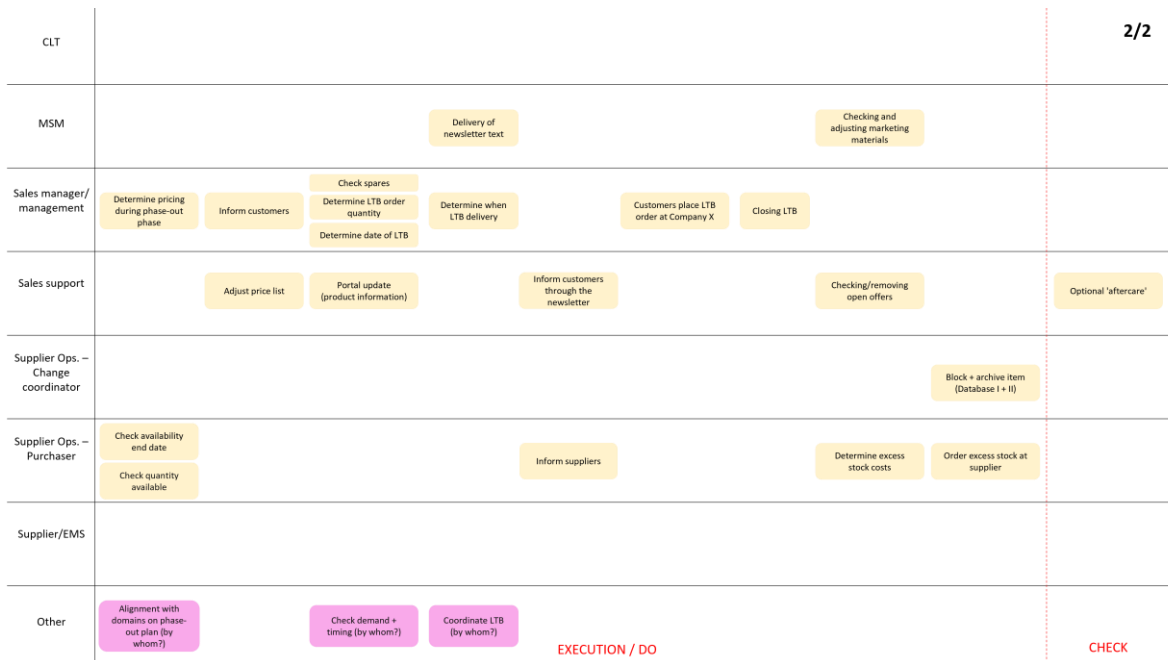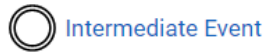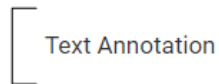
EXECUTION / DO — **CHECK**

2/2

Figure 33 - Results desired situation workshop (page 2/2)
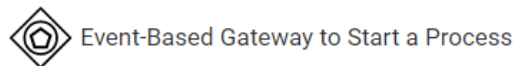
Appendix B – BMPN Symbols Legend

Event

◯ Start Event

◎ Intermediate Event

◯ End Event

Activity

▢ Task

▢ Sub Process

▢ Call Activity

Artifact

Group

Text Annotation

Gateway

◇ Exclusive Gateway - without Marker

◇✕ Exclusive Gateway - with Marker

◇◎ Inclusive Gateway

◇✛ Parallel Gateway

◇✳ Complex Gateway

◇◎ Event-Based Gateway

◇◎ Event-Based Gateway to Start a Process

◇⊕ Parallel Event-Based Gateway to Start a Process

Flow

→ Sequence Flow

○- - - - -⇢ Message Flow

· · · · · · · · · · · Association

· · · · · · · · ·➤ Data Association

Data

📄 Data Object

📄 Data Object Collection

📄 Data Input

📄 Data Input Collection

📄 Data Output

📄 Data Output Collection

🗄 Data Store

Swimlane Basics

Lane

Pool

Figure 34 - BPMN Symbols Legend (View the BPMN Quick Guide - BPMN Quick Guide, 2023)

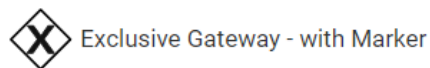## Appendix C – Interview questions for other business units
(Benchmarking)

Give an introduction about objective of the interview and explain the thesis assignment.

1. What is your role within the business units?
2. What is the current approach to product phase-out within your business units?
3. What are the triggers for starting a product phase-out? Are these reactive or proactive triggers?
4. What is the decision-making process around phasing out products at your business units and what steps are taken in these processes? Is a situation handled ad-hoc or do you have a procedure for this?
5. How far in advance do you determine if a product should be phased out?
6. How does communication and cooperation take place within the departments in your business units?
7. In what ways do your business units involve customers and suppliers in the product phase-out process? When, how and on what are customers informed or consulted about product phase-out?
8. Have you assigned individuals responsible for coordinating the product phase-out?
9. Are there lessons your business units have learned from previous product phase-outs that might be useful to share?
10. Are there any specific plans or strategies your business units have to improve or optimize the product phase-out process?
11. How do your business units conduct risk assessments related to product phase-out? What risks are considered and how are they assessed?
12. Do you have anything else that you want to share?

Appendix D – Interview questions for customers
(About product phase-out and customer satisfaction)

Give an introduction about objective of the interview and explain the thesis assignment.

1. How has communication and cooperation during product phase-out been in the past?
2. Do you have examples of products that have been phased out in the past and how these processes have proceeded?
3. How has the product phase-out affected your operations (inventories, operational processes, etc.) and customer satisfaction?
4. What are the key factors for customer satisfaction for your company?
5. How do you see the division of roles in terms of the product phase-out for you?
6. What do you think are Company X 's current weaknesses and strengths in terms of product phase-out?
7. Where do you see improvement opportunities to strengthen collaboration, act more proactively and increase customer satisfaction?
8. Do you have any specific guidelines or expectations regarding communication and customer satisfaction in the collaboration with Company X?
9. Do you have examples of how other suppliers of yours handle the phasing out of products and how this process unfolds?
10. What are best practices from other suppliers of yours that could be useful to us?
11. Would you be open to a more active involvement and closer collaboration to make the (phasing in and) phasing out process of products more proactive?
12. Do you have anything else that you want to share?

Appendix E –Interview questions for suppliers

(About product phase-out, obsolete management and change management)

Give an introduction about objective of the interview and explain the thesis assignment.

1. How does your company identify and manage obsolete components or materials?
2. Does your company use certain strategies for (proactively) identifying and managing obsolete components? (e.g. technology monitoring, risk analysis, market research/trend analysis, inventory management, resolution/mitigation strategies etc.)
3. In what way are you involved in the phase-out process of Company X products? What steps are you taking in this process?
4. Do you have examples of products that have been phased out in the past and how these processes have proceeded?
5. How is the inventory of these products managed (strategies for minimizing costs and excess stock)?
6. How is current communication and collaboration during the product phase-out process?
7. How do you see the division of roles in terms of product phase-out for you?
8. Do you have examples of how other clients of yours are handling obsolesce management and product phase-out?
9. What are best practices from other clients of yours that could be useful to us?
10. What do you feel are Company X 's current weaknesses and strengths in obsolesce management, change management and the product phase-out?
11. Where do you see improvement opportunities to strengthen collaboration and act more proactively?
12. Would you be open to a more active involvement and closer collaboration to make the phase-out process and obsolete management of products more proactive and efficient?
13. Do you have anything else that you want to share?

Validation of research on the phase-out process

Dear colleague,

I would like to thank you for collaborating in my research on optimizing the phase-out process within Company X. Through several sessions and interviews with you, I was able to gather all the information and create an optimized model for the phase-out process. In addition, there were several interviews with business partners, suppliers and representatives of other business units, based on which several recommendations could be made.

As a result, I created a process model, already presented to you during a validation meeting. Now, to fulfil requirements related to my thesis at the University of Twente, I need to collect more precise data about the quality of the model and other results of my thesis. I would really appreciate it if you could help me, by filling in this questionnaire. This should take no more than 15 minutes.

I thank you in advance for your support.

Best regards,

Boín Spée

Section 1: Developed business process model
The next 7 questions are about the developed business process model. The process model is attached to the email if you would like to view it again.

Question 1:

The developed business process model provides more insights on **what activities** need to be performed during the phase-out process.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 2:

The developed business process model provides more insight into **when activities** should be performed during the phase-out process.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 3:

The developed business process model is too bureaucratic, adding **too many and** *
unnecessary activities to the phase-out process.

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 4:

The developed business process model provides a better understanding of *
responsibilities during the phase-out process.

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 5:

The developed business process model is **confusing in terms of how the** *
interaction between different process participants happen during the phase-out
process.

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 6:

The developed business process model provides a clearer view of **which** *
information is used and produced during the phase-out process.

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 7:

Overall, the Business Process Model provides a more **structured** and **well-documented** version of the phase-out process.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The following KPIs have been established to measure and monitor the performance of the phase-out process.

- **Excess Stock Quantity:** the amount of excess stock
- **Costs:** the total costs due to incorrect stock estimates
- **Time-to-Phase-Out:** the time that it takes to phase-out a product or component
- **Customer Satisfaction**: the extent to which customers are satisfied with the product phase-out
- **Communication Effectiveness**: the extent to which stakeholders are informed and remain informed during the phase-out process
- **Employee Awareness**: The extent to which employees are aware of the procedures surrounding product phase-outs
- **Percentage of Unplanned Product Phase-Outs**: the percentage of product phase-outs that occur unplanned.
- **Stakeholders Engagement**: the extent to which stakeholders are involved and working together.
- **Total Number of Products in Portfolio**: The total number of active products in the product portfolio

Question 8:

"Please share your thoughts about these KPIs. What is your opinion about them? Would you remove any from the list or add some other KPIs? If so, please explain why."

Section 2: Recommendations, risks and customer satisfaction

In brief, the following recommendations and insights were generated through the research:

- Form a **phase-out team**, with representatives from MSM, Sales, Operations and R&D, and designate one of them as responsible for coordinating and initiating the phase-out process.
- Create a **PLM portfolio list**. This list should reflect the life cycle phase of products and the phase-out date of products. This list should be reviewed, evaluated and updated at a **semi-annual meeting** based on input from the technical and commercial side.
- Phase-outs should be initiated **two/three years** in advance and the phase-out should be triggered based on the PLM portfolio list (proactive approach).
- Start measuring and monitoring the proposed **KPIs**. By measuring these KPIs, a better understanding of the performance of the phase-out process can be gained, weaknesses can be identified and new opportunities can arise.

The next 4 questions relate to customer satisfaction.

Based on the interviews with the business partners, the following customer satisfaction factors emerged:

- Timing of the communication
- Successor Costs
- Quality of the information
- Reliability of the information

Question 9:

The recommendations and the developed process model contribute to increasing *
the customer satisfaction factor 'Timing of communication'.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 10:

The recommendations and the developed process model contribute to increasing *
the customer satisfaction factor 'Successor Costs'

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 11:

The recommendations and the developed process model contribute to increasing *
the customer satisfaction factor 'Quality of the information'

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 12:

The recommendations and the developed process model contribute to increasing *
the customer satisfaction factor 'Reliability of the information'

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

The next 4 questions relate to the identified risks.

Based on the interviews and workshops the following risks are identified:

- Financial risks
- Operational risks
- Customer satisfaction risks
- Portfolio management risks

Question 13:

The recommendations and developed process model contribute to reducing or *
mitigating financial risks.

	1	2	3	4	5	
Strongly disagree	O	O	O	O	O	Strongly agree

Question 14:

The recommendations and developed process model contribute to reducing or
mitigating operational risks.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 15:

The recommendations and developed process model contribute to reducing or
mitigating customer satisfaction risks.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 16:

The recommendations and developed process model contribute to reducing or
mitigating portfolio management risks.   *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Section 3: Final questions
Question 17:

Overall, the research findings lead to a more proactive approach to the phase-out *
process.

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 18:

Overall, the research results make the phase-out process too complex and time- *
consuming

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Question 19:

"Do you have any final positive or negative remarks about the research? If so, please explain
below:"

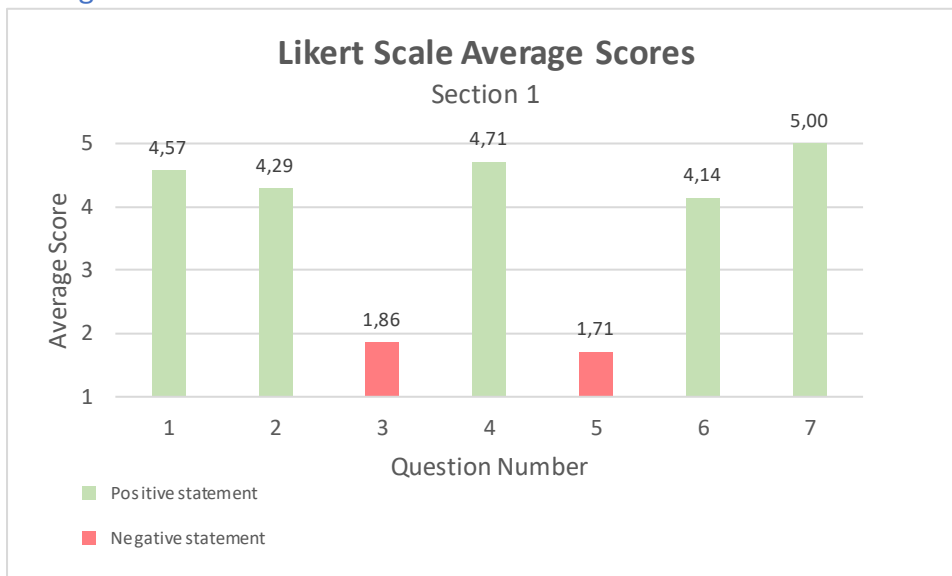## Appendix G – Validation survey results

Average scores on the Likert scale

Likert Scale Average Scores
Section 1

Figure 35 - Average Likert Scale scores question 1 to 7

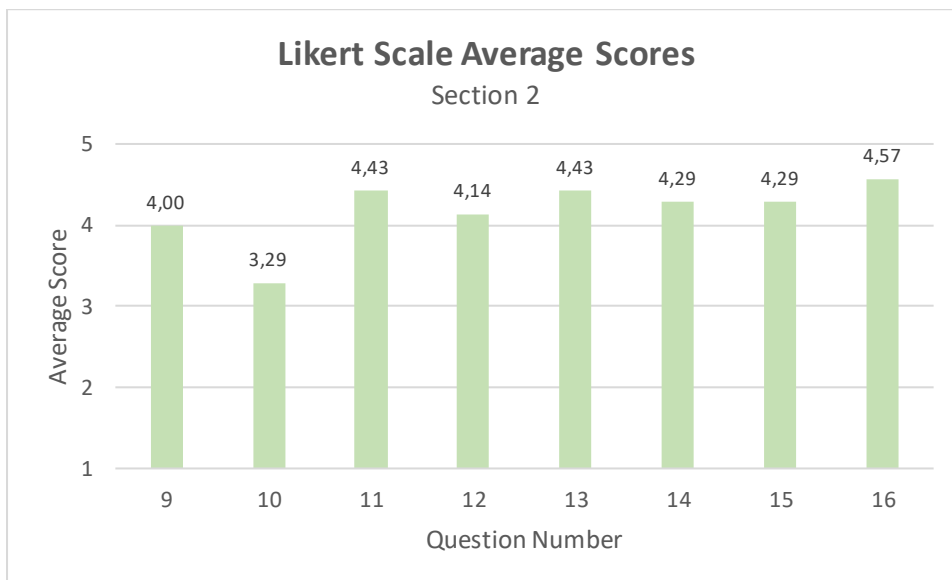**Likert Scale Average Scores**
Section 2

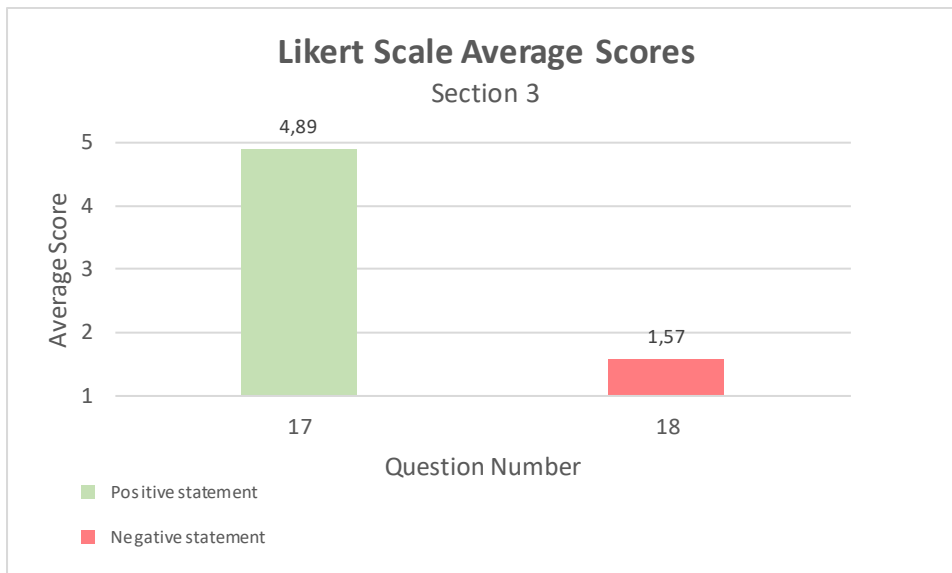*Figure 36 - Average Likert Scale scores question 9 to 16*

Figure 37 - Average Likert Scale scores question 17 and 18

Answers to open-ended questions
<u>Question 8:</u>

- I think these KPIs fit well with the phase-out process. It is a mix between KPIs focused on employees, customers, planning and costs. In this way phase outs can be measured from different perspectives.
- When we phase out a product, it is too easy and then we see the cost and have to explain to everyone why.
- I'm not sure about measuring the customer satisfaction. I think we should measure this different, more in terms of general satisfaction, not based specific on the phase-out.
- Besides, I think Employee Awareness and Stakeholders Engagement have overlap. Stakeholders Engagement seems unnecessary to me. Most important is that people know the process and know who the stakeholders are.
- Some KPI's difficult to predict what is a realistic optimum
- These KPI s are ok for me, but there must be a difference in a phase out product instead of phase out component.
- Something that reflects the lead time of the phase out process
- I think these KPI's will help to explain the importance of the topic. Stakeholder engagement is less important to me.

- You managed to visualise a very complex process in a clear and orderly way.
- No
- Well done Boín! I hope Company X will be able to execute the process and use the findings you presented to us.
- I think it is really important to implement the recommendations into our organization.
- The last question is a 4 or a 3 and I give it a 3 because off the process. If we start working this way, we'll know after implementation that it's really good.
- Very nice result and I notice a lot of enthusiasm in the organization to follow up on this and directly include the Phase-in. Thanks!
- Compliments for your research and the report. You have taken the lead during the process, guided the workshops and you have clearly explained the results to multiple teams. The feedback I have heard from different people is that the clear process models are really helping them to understand the different steps, responsibilities and urgency. You can be proud of what you have achieved in such a short time.