Lead Time Improvement on the Order-to-Delivery Process: A Case Study on a Paint and Coatings Company

by

Valdo Pratama

Submitted to the Faculty of Technology, Policy, and Management
in Partial Fulfilment of the Requirement for the Degree of
Master of Science
in
Management of Technology
at the
Delft University of Technology

to be defended publicly on Thursday, 28 November 2024

General Information

Student Name	Valdo Pratama
Student Number	5702313
Project Duration	15 May 2024 – 28 November 2024

Academic Information

University	Delft University of Technology
Faculty	Faculty of Technology, Policy, and Management
Program	MSc Management of Technology
Specialization	Supply Chain Management

Graduation Committee

Chairman & Second Supervisor	Prof. dr. ir. G.L.L. (Genserik) Reniers (Section 3S, Department VTI, Faculty TPM)
First Supervisor	ir. M.W. (Marcel) Ludema (Section T&L, Department ESS, Faculty TPM)

TU Delft

Preface

I would like to express my sincere gratitude to my supervisors at TU Delft, Marcel Ludema and Genserik Reniers, for their continuous guidance, patience, and support throughout this Master's thesis project. I would also like to thank the people who have helped me throughout my thesis journey.

I extend my heartfelt thanks to my parents for their support and prayers and for giving me the opportunity to study abroad. To all my friends, thank you for supporting me through this journey. I wish you all the best in your future endeavors.

I hope this thesis inspires future research in the field of supply chain management, and may these findings contribute to a better future for the Management of Technology.

"A smooth sea never made a skilled sailor"

-Franklin D. Roosevelt

Valdo Pratama

Delft, 24 November 2024

Summary

Disclaimer: These findings represent hypothetical or industry-wide challenges and may not fully reflect real-world conditions or applications.

This thesis proposes actionable strategies for improving the lead time performance of the order-to-delivery process for a specialized product in a paint and coatings company serving a targeted regional market. The study encompasses background analysis, current state examination, solution generation, feasibility assessments, and validation of proposed improvements.

The paint and coatings industry has a long history, evolving from ancient natural pigments to modern synthetic products driven by technological advancements. Effective supply chain management is crucial for maintaining product quality and meeting customer expectations in this competitive market. Challenges such as geopolitical issues and logistical constraints emphasize the need for robust lead time management to sustain a competitive edge.

The primary problem investigated involves the lead time of the specialized products extending that exceeds the targeted service level, which results in significant delays, leading to customer dissatisfaction, increased costs, and diminished market responsiveness. A mixed-methods research approach was employed within Lean Six Sigma's DMAIC framework, integrating qualitative and quantitative data to address this. Data collection included process maps, stakeholder interviews to fill knowledge gaps, and quantitative data from the company's inventory management system. The analysis focused on orders from 2023 to ensure complete lead time measurement. Validation was conducted through triangulation using literature, company reports, and stakeholder feedback, guaranteeing consistency across data sources.

The findings revealed that approximately 8% of products accounted for nearly 80% of lead time issues, highlighting targeted areas for impactful change. Root cause analysis indicated that a lack of urgency in improvement efforts led to insufficient measurement practices. At the same time, process mapping identified inefficiencies such as manual data entry and the need for better communication. These findings highlighted the need for standardized workflows, clear roles, and a continuous improvement culture.

The proposed solutions included developing an integrated supply chain grand design, end-to-end process map and measurement, standardizing documentation, reporting method, and communication, fostering continuous improvement culture, and implementing scheduled reviews, awareness, and improvement of tools. Feasibility was assessed using SWOT and cost-benefit analyses, recommending immediate standardization actions and phased implementation for more complex strategies like the supply chain grand design and continuous improvement culture. The findings were validated by company representatives who agreed on the potential benefits, though further internal assessments were suggested to address specific implementation constraints.

The research provides several recommendations that include:

1. Establish a clear blueprint outlining processes, targets, roles, and responsibilities, which can be supported by an integrated supply chain grand design.
2. Map end-to-end processes, gather data, measure activities, and collaborate with stakeholders to address process gaps using data-driven decision-making.
3. Standardize, organize, and optimize existing processes, documents, reports, and communication to enhance efficiency and clarity.
4. Foster a continuous improvement mindset and customer-centric approach to enhance purpose and outcomes.
5. Schedule regular evaluations of tools and processes to identify and minimize defects proactively.

Table of Contents

List of Figures

List of Tables

1 Introduction

Chapter 1 introduces the research project overview, emphasizing its significant contribution to the supply chain management and technology field. Section 1.1 provides a general overview of the paint and coatings industry and how lead time is related to the industry's supply chain. Section 1.2 defines the complex problem occurring in the paint and coatings industry, leading to the development of the research objectives (Section 1.2.1) and research questions (Section 1.2.2) to address the problem. Section 1.3 elaborate the comprehensive project deliverables, demonstrating the thoroughness of the research. Section 1.4 explains the relevance of this research project to the MOT program study. Section 1.5 provides an overview of the report structure.

1.1 Background of the Paints and Coatings Industry and the Relation to Supply Chain

The paint and coatings industry has a rich and extensive history dating back thousands of years. Ancient civilizations utilized natural pigments and materials to produce decorative and protective finishes. The modern evolution of this industry began in the 19th century, driven by the introduction of synthetic pigments and binders. The Industrial Revolution further catalyzed this transformation through technological advancements, leading to mass production and the development of a diverse range of products for various applications. In principle, paints and coatings serve two primary purposes: protection against environmental and mechanical forces and fulfilling aesthetic needs (American Coatings Association, 2021). Modern products encompass three main types: architectural coatings for enhancing building aesthetics, industrial coatings for specific applications in manufacturing and transport, and specialty coatings designed to withstand extreme conditions (e.g., high abrasion, corrosion) (Weiss, 1997).

The industry's supply chain comprises raw material procurement, production, distribution, sales, and R&D, each playing a vital role. Securing solvents, pigments, additives, and binders is critical, with raw material availability directly influencing production quality. Challenges such as geopolitical issues, logistics constraints, and fluctuating transport costs have disrupted sourcing (Sikharulidze & Fuschi, 2023).

Unlike consumer goods, paints and coatings products are more difficult to substitute due to their system-based nature, tailored to specific applications and end-user needs. In response to these complexities, companies are investing in research and development, forming strategic partnerships, and focusing on customer satisfaction to maintain a competitive edge (Fortune Business Insights, 2024). In this competitive and fragmented market, effective supply chain management remains a critical factor for success.

Supply chain management is crucial in the paints and coatings industry to ensure that products are delivered to customers in the right quality, quantity, and time while maintaining competitiveness and achieving strategic objectives. This supply chain encompasses all stages, including raw material procurement, production, distribution, and customer fulfilment. Inefficiencies in the supply chain can have significant negative impacts, such as increased operational costs due to resource wastage, excess inventory, and the need for expedited shipping

to meet deadlines. Companies may also face frequent stockouts or overstock situations, disrupting production schedules and diminishing customer satisfaction. Factors contributing to these inefficiencies include poor communication, lack of visibility across the supply chain, supplier issues, network disruptions, security concerns, and ineffective inventory management (Yu, 2024). High lead times, a critical metric in supply chain operations, further exacerbate these challenges, impeding the company's responsiveness to market demands and eroding its competitive edge

Improving lead time is essential for optimizing the end-to-end supply chain. Reducing lead time enhances customer satisfaction by ensuring timely delivery, minimizes additional costs, and increases overall operational efficiency. For paint and coatings companies, this involves streamlining processes from raw material procurement to product delivery to the customer.

End-to-end visibility is becoming increasingly important for companies to ensure product traceability and meet environmental and social commitments. The integration of digital technologies has enhanced efficiency and safety, and retraining workers to use these technologies has become a priority (Guarraia & Zech, 2021). For the paints and coatings industry, improving demand forecasting and planning, reducing warehouse and logistics costs, and minimizing material losses through enhanced efficiency are critical strategies for achieving cost reduction and overall supply chain optimization (Beier, et al., 2024).

1.2 Problem Definition

Our main scope is the specialty coatings of a specialized product of a paints and coatings company for a regional market. The company receives many customer complaints due to delays in the arrival of customer orders. However, the numbers are not specified due to limited documentation in the customer complaint report. Currently, most of the lead time for the specialized product, from the customer placing the order to receiving the product from a production facility in Europe to a regional market customer, experiences significant delays in the lead time relative to the expected service level. This protracted timeframe poses several challenges: a decrease in customer satisfaction level, increased costs, diminished responsiveness to market demands, and the risk of lost sales due to an inability to adapt quickly to changes in customer preferences and demand. Addressing these extended lead times is vital to improve service levels, enhance customer satisfaction, reduce costs, and sustain a competitive edge within the region.

1.2.1 Research Objectives

This research project aims to propose actionable strategies to improve the current lead times performance in the specialized product's order-to-delivery process to the company's regional market customers. The objective of this project includes:

1. Understand the current relative position of the company based on the background study conducted.
2. Understanding the current process and activities in the order-to-delivery process.
3. Measure the lead time of the current order-to-delivery process.
4. Identifying key factors that influence the process and the decision-making of the stakeholders.

5. Analyze and identify possible root causes from the current process.
6. Develop an improvement solution for the identified problems.
7. Assess the feasibility and risk of the improvement options.
8. Create a preliminary implementation plan for the solutions.
9. Conduct a validation of the findings with the company.
10. Summarize and propose actionable strategies from the findings.

1.2.2 Research Questions

To reach the project's objective, research questions are made to structurally guide the project's flow to ensure the goal of improving the lead time in the order-to-delivery process. The **main research question** of the project is:

"How to improve the order-to-delivery process performance in the targeted regional market?"

Following the main research question, sub-research questions are created to construct a solid foundation for answering the main research question. The **sub-research questions** (SRQ) are defined as

1. **SRQ1**: What is the company's relative position based on the conducted background study?
2. **SRQ2**: What is the current process performance of the targeted regional market?
3. **SRQ3**: What are the root causes of the current lead time performance in the order-to-delivery process, and what are the directions for achieving the improvements?
4. **SRQ4**: What are the actionable strategies for implementing the potential solutions in the supply chain, and how can the company measure the success of the implementation concerning the lead time?
5. **SRQ5**: How do the company representatives accept and find the proposed improvements for the order-to-delivery process implementable and impactful, and what feedback can they provide for further refinement?

The details of how to answer the main- and sub-research questions will be discussed in Section 2.1.

1.3 Project Deliverables

The thesis project is expected to give several deliverables after assessing the findings. The main output of the research is based on the research objective, which is a set of **recommendations of actionable strategies** to implement solutions based on the feasibility and immediate needs to improve the current performance concerning lead time. Additionally, this study will contribute to the **scholarly understanding** of the order-to-delivery process and the actionable strategies in the paints and coatings supply chain, especially with the scope, condition, and situation in the regional market. Moreover, the sub-research questions will also produce several supplementary outcomes that include:

1. **From Sub-research question 1 (SRQ1)**:
    1. The current relative position of the company is based on background study literature.

2. **From Sub-research question 2 (SRQ2)**:
    1. Current lead time assessment from data of the company's inventory management system.
    2. Process mapping and lead time information of the current order-to-delivery process.
    3. Key factors that may affect the lead times in the regional market.
3. **From Sub-research question 3 (SRQ3)**:
    1. Root cause analysis of the lead time problem.
    2. Improvement solution options for the order-to-delivery process.
4. **From Sub-research question 4 (SRQ4)**:
    1. Recommendation of possible improvement strategies for the company.
    2. Feasibility assessment of the possible improvement solutions.
    3. Preliminary implementation plan of the improvement solutions.
5. **From Sub-research question 5 (SRQ5)**:
    1. Validation of the research findings and solutions proposed through feedback and discussion with the company regarding the feasibility of implementation and impact of the actionable strategies proposed to improve the lead time performance of the order-to-delivery process.

1.4 Management of Technology and Academic Relevance

This thesis is written as part of the graduation project of the MSc Management of Technology (MOT) program at the Delft University of Technology (TU Delft). MOT graduates are expected to explore, understand, manage, and implement technology as a corporate resource to improve and leverage outcomes from a corporate perspective. Specifically for this thesis, several courses and subjects are covered to run the project, such as (digital) business process management, research methods, logistics and supply chain innovation, logistic system engineering, etc.

Academically approaching the problem using scientific methods and techniques, the focus is on improving the current lead time and process of the case study order-to-delivery process to achieve a better customer satisfaction level in the technological context and enrich the pool of knowledge for MOT and MOT-related academic fields. The master's thesis and research project are considered relevant to the MOT criteria and impactful to the company.

1.5 Report Outline

The report consists of seven (7) main chapters that are grouped into five (5) parts based on the DMAIC framework, which will be discussed in Section 2.1. Each part builds up the answer to the sub-research question by introducing chapters that lead to the conclusion of the main research questions. Each chapter contains several sub-chapters explaining the steps taken to answer each chapter. The outline of the report is explained below.

Part I: Define

Part I corresponds to the *Define* phase of the DMAIC framework, which includes Chapters 1, 2, and 3. It will discuss how the problem is defined individually through the introduction to the problem, methodology, and background study to understand the theory and knowledge used in conducting this research.

- **Chapter 1: Introduction**
  The introduction gives the initial understanding regarding the initiation, direction, and output of the project by discussing how the manufacturing industry relates to extensive supply chain operations and how the supply chain performance may be the key to the industry's sustainability. This chapter provides the background of the project (see Section 1.1), problem definition that includes the research objectives and research question to help guide and propose solutions to the problem (see Section 1.2), and the output or deliverables of the project (see Section 1.3). Moreover, the chapter describes the relevance and significance of the study (see Section 1.4) and the structure of the report (see Section 1.5).
- **Chapter 2: Thesis Project Methodology**
  The thesis project methodology chapter explains how the research will be designed and approached to answer the research questions. The chapter begins by addressing the DMAIC framework used to systematically answer the research questions (see Section 2.1), followed by what methods were used to support each phase of the framework (see Section 2.1.1). Then, the chapter is followed by an explanation of how and what data is collected (see Section 2.2), how the findings are validated, and how the reliability of the output is ensured (see Section 2.3).
- **Chapter 3: Background Study**
  This chapter provides a comprehensive background study of the project, including the available frameworks, methodologies, and methods used specifically for this project. Here, several key background topics are explained, including the supply chain model that specifies the order-to-delivery process in the manufacturing industry and how time is a strategic performance measurement (see Section 3.1). Lean Six Sigma frameworks (see Section 3.2) and the 3P framework (see Section 3.3) are introduced to complement the findings of the project. The continuous improvement tools that are utilized in the project are described here (see Section 3.4). A business process change management principle is discussed as to how it is applied in the solutions of the findings (see Section 3.5). Then, the background study literature is applied to know the current relative position of the company based on the background study (see Section 3.6). Finally, the chapter ends with a sub-conclusion to summarize the background study and how it is applied in the actual situation (see Section 3.7).

Part II: Measure

Part II corresponds to the *Measure* phase of the DMAIC framework. This part only includes Chapter 4 where it will describe the current situation and the scope of the order-to-delivery process. A sub-conclusion of the chapter is available at the end of the chapter (see Section 4.4).

- **Chapter 4: Current Situation**
  The chapter starts with the lead time of the current order-to-delivery process (see Section 4.1), which explains the process of quantitative data modeling and collecting (see Section 4.1.1), the process of scoping based on the valuation of the company's customer (see Section 4.1.2), and visualizing the lead time calculation of the scoped customer (see Section 4.1.3). The aim of analyzing this project is to obtain quantitative data on the lead time from the inventory management system. After that, the chapter shows the process mapping of the order-to-delivery process in a BPMN diagram (see Section 4.2). This is done to know and

visualize the flow of the process and the activities conducted by the stakeholders throughout the process (see Section 4.2.1 to Section 4.2.4). Then, the scope and limitations of the current situation data collection are mentioned to give information on the assumptions used when collecting the data (see Section 4.3). Therefore, the analysis in the later stage has already considered the boundary of the conditions in the project. Finally, the chapter ends with a sub-conclusion to summarize the current situation of the order-to-delivery process (see Section 4.4).

Part III: Analyze

Part III corresponds to the *Analyze* phase of the DMAIC framework. This part only includes Chapter 5, where it will explain the analysis of the current situation of the findings in Chapter 4.

- **Chapter 5: As-Is Analysis**
  The chapter will discuss the analysis from the quantitative and qualitative findings of the lead time shown as the current lead time assessment (see Section 5.1), which is done using Pareto analysis (see Section 5.1.1), followed by the root cause analysis method of 5 Why to obtain the root cause of the chosen products (see Section 5.1.2). Then, the result of the assessment is added in the key factor analysis section (see Section 5.3). A process map assessment is also conducted by analyzing the current process qualitatively and support from some quantitative data in the process mapping (see Section 5.2). The findings of the process map are also supporting the key factor analysis (see Section 5.3). The key factor analysis consists of the cause-and-effect diagram and in-depth analysis by the tool to identify possible root causes since the direct cause of the problem is not known (see Section 5.3). Finally, the chapter ends with a sub-conclusion to summarize the current situation analysis findings to have the areas for improvement in the process (see Section 5.4).

Part IV: Improve

Part IV corresponds to the *Improve* phase of the DMAIC framework. This part only includes Chapter 6, where the chapter will elaborate on the improvement generation from the As-Is analysis result in Chapter 5.

- **Chapter 6: Improvement**

  The chapter will discuss the solution generation based on the assessed root causes in Chapter 5. The possible solutions are generated to tackle the root causes found in the previous chapter (see Section 6.1). Each of the solutions is discussed in more detail in each sub-chapter (see Section 6.1.1 until Section 6.1.5), including the important aspects that the solutions must cover to effectively solve the issues from the findings. Next, a feasibility assessment is conducted to assess further the possibility of the solution being successfully and feasibly implemented by the company (see Section 6.2). The feasibility assessment consists of two methods, which are the SWOT analysis (see Section 6.2.1) and cost-benefit analysis (see Section 6.2.2).

  From the feasibility assessment results, the solutions' actionable strategies are generated (see Section 6.3), and the implementation plan is also proposed and elaborated for further ideas so the company can improve the order-to-delivery process performance (see Section 6.4). Therefore, the study has generated, assessed, strategized, and proposed the

implementation of solutions that could improve the flow of the order-to-delivery process. Then, the findings are presented to the company for validation with the company's representative to see the thoughts regarding the strategies proposed and gather feedback in addition to the findings of this project further to enrich the implementation and feasibility of the solution (see Section 6.5). Finally, the chapter ends with a sub-conclusion to summarize the improvement proposal, feasibility assessment, implementation plan designed, and validation confirmation (see Section 6.6).

Part V: Control

Part V corresponds to the *Control* phase of the DMAIC framework. This part only includes Chapter 7, where it will conclude the recommendations for the company for further actions to improve the performance of the current order-to-delivery process.

- **Chapter 7: Conclusion and Recommendations**
  The chapter will conclude all the findings from Chapters 1 to Chapter 6, providing comprehensive answers to address the main research question and sub-research questions (see Section 7.1). The chapter also includes recommendations for further emphasis on key points in the findings (see Section 7.2) and suggest areas for further research for sustainable improvement (see Section 7.3).

2 Thesis Project Methodology

Chapter 2 presents the research methodology used in this study. Section 2.1 provides an overview of the methodologies and methods employed, explaining how they connect the study from introduction to conclusion and address the research questions to produce the project deliverables (Section 2.1.1). Section 2.2 covers the background and strategy for data collection, including details on the unit of analysis and data sampling methods (Section 2.2.1). Section 2.3 explains the measures taken to ensure the validity and reliability of the project findings. Overall, this chapter establishes a clear foundation for how the research was conducted and ensures the credibility of the results.

2.1 Thesis Project Framework

The research framework is constructed from Lean Six Sigma's DMAIC framework approach. The sub-research questions will address all the components in the DMAIC framework. Similar thesis projects by Jacquemijns (2017) and Porozantzidou (2015) have successfully applied the DMAIC framework to process improvement projects within a company setting. The rationale of the structure in analyzing the problem is assessed as objective, structured, and systematic. Hence, the DMAIC framework approach will be used in this project. Figure 1 shows the flow diagram that visually represents the research framework using the DMAIC framework. Furthermore, Section 2.1.1 will elaborate on the research methods to answer the sub-research questions within the defined research framework.

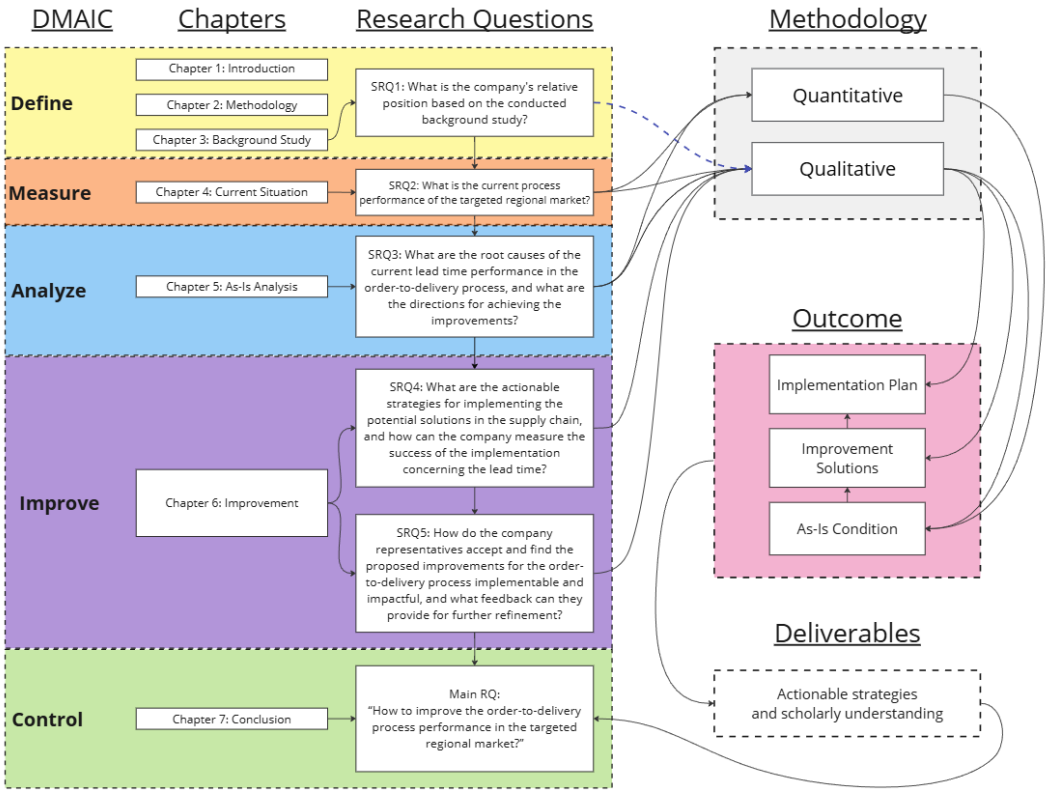

Figure 1 Research Methodology Overview

2.1.1 Research Methods

The designated chapter of the report provides a more detailed explanation of how the research methodologies can answer the sub-research questions, research methods, and tools. Figure 2 the flow diagram provides a detailed overview of which research methodologies and research methods are associated with chapters of the thesis and how they relate to the research questions.

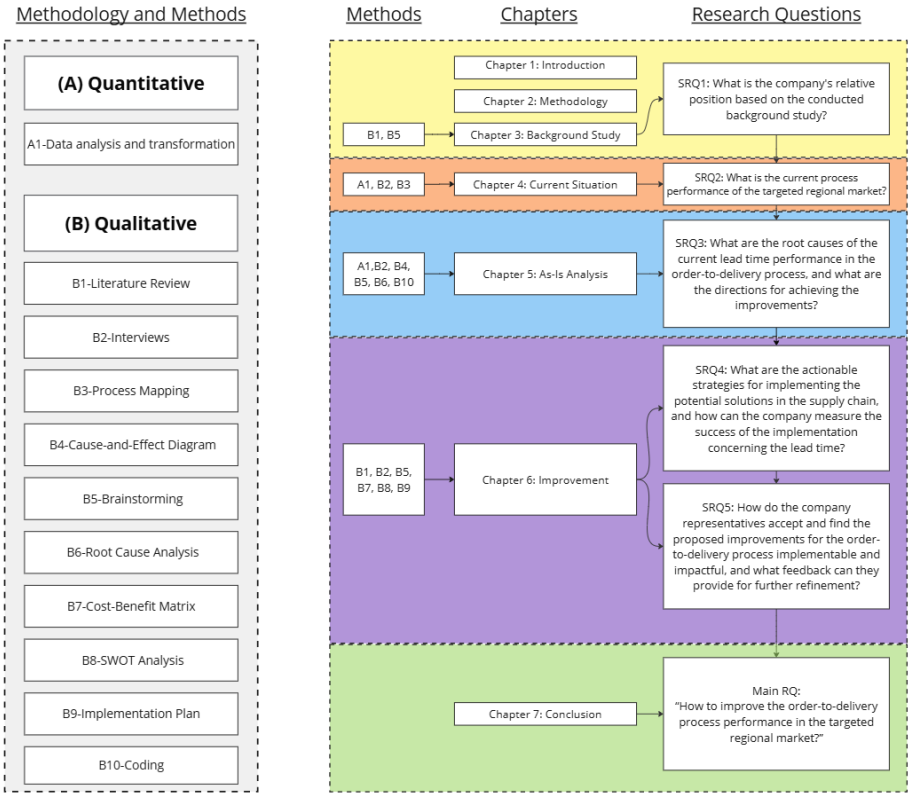

Figure 2 Research Methodology and Methods Used

The left section of Figure 2 breaks down the research methodology into two main approaches:

1. **A: Quantitative Methods**
    - **(A1) Data Analysis and Transformation**: Quantitative methods are used to analyze and transform data. It is a critical part of the research, primarily linked to understanding the current condition of the order-to-delivery process. Data collected from the company's inventory management system is primarily processed with Microsoft Excel tools such as Power Query and PivotTable, bringing new insights from the collected data.
2. **B: Qualitative Methods**
    - **(B1) Literature Review**: Conducted to gather existing knowledge and contextual understanding relevant to the research.
    - **(B2) Interviews**: Used to gather insights from key stakeholders about the order-to-delivery process.

- **(B3) Process Mapping**: Visualizes the current process flow and identifies key areas for improvement.
- **(B4) Cause-and-Effect Diagram**: A tool used to identify and analyze the root causes of delays or inefficiencies in the process.
- **(B5) Brainstorming**: Utilized to generate ideas and potential solutions for process improvements.
- **(B6) Root Cause Analysis**: Involves systematically identifying the underlying causes of issues within the order-to-delivery process to inform improvement strategies.
- **(B7) Cost-Benefit Matrix**: Used to evaluate the potential costs and benefits of proposed improvements.
- **(B8) SWOT Analysis**: Assesses the strengths, weaknesses, opportunities, and threats of the company related to the proposed changes.
- **(B9) Implementation Plan**: Outline how to and how long the proposed improvements will need to be implemented and monitored.
- **(B10) Coding**: Qualitative data analysis method to identify related content across qualitative data, especially in text-source data, such as interviews, etc.

The linkages between the methodology and methods (Figure 2-Left Side), with chapters and research questions (Figure 2-Right Side) can be explained as:

Sub-research question 1 (SRQ1): The sub-research question **"***What is the company's relative position based on the conducted background study?*" is related to Chapter 1 to 3 where the question seeks to answer the company's relative position within the background study conducted. Chapter 1 and Chapter 2 are providing a general overview of the project. The methods used to construct Chapter 3 is a literature review (B1) to understand the background study that discusses the supply chain model, Lean Six Sigma frameworks, continuous improvement tools, business process change management theories, and how it is applied to map the company's relative position. The sub-research question is answered through the methods of literature review (B1), brainstorming (B5), and SWOT analysis (B8) that are discussed and applied in Chapter 3.

Sub-research question 2 (SRQ2): The sub-research question "*What is the current process performance of the targeted regional market?"* is related to Chapter 4, where this question seeks to understand and measure the current process map and lead time for the order-to-delivery process. Chapter 4 will focus on measuring the current situation of the problem using data analysis and transformation (A1), interviews (B2), and process mapping (B3). Data analysis and transformation (A1) will gather and model the required information to obtain the current situation of the process. Process mapping (B3) uses information from interviews (B2) with the process stakeholders.

Sub-research question 3 (SRQ3): The sub-research question "*What are the root causes of the current lead time performance in the order-to-delivery process, and what are the directions for achieving the improvements?"* is related to Chapter 5 where this sub-research question focuses on analyzing the current process and what improvement can be made on the performance of the

lead time that occurs on the process. Chapter 5 will use data analysis and transformation (A1), interviews (B2), cause-and-effect diagram (B4), brainstorming (B5), root cause analysis (B6), and coding (B10). Data analysis and transformation (A1) uses Power Query and Pareto principles from root cause analysis to obtain a more granular insight into the problem. The root cause analysis (B6) includes the 5 Why methods to obtain the root cause of the situation, and the cause-and-effect diagram (B4) is used as a method to visualize all the possible causes that may lead to high lead time from the coded interview result (B2, B10).

Sub-research question 4 (SRQ4): The sub-research question "*What are the actionable strategies for implementing the potential solutions in the supply chain, and how can the company measure the success of the implementation concerning the lead time?*" is related to Chapter 6, where it will use the result from Chapter 5. Moreover, the methods used to construct the practical strategies are literature review (B1), interviews (B2), brainstorming (B5), cost-benefit matrix (B7), SWOT analysis (B8), and implementation plan (B9). The cost-benefit matrix (B7) and SWOT analysis are used for the feasibility assessment, and the implementation plan (B9) is to construct a preliminary timeline and action plan for the proposed solutions.

Sub-research question 5 (SRQ5): The sub-research question "*How do the company representatives accept and find the proposed improvements for the order-to-delivery process implementable and impactful, and what feedback can they provide for further refinement?*" is related to Chapter 6 it focuses on validating the research findings from the company's perspective. The methods used are interviews (B2) to present the research findings and gather stakeholder feedback and brainstorming (B5) to discuss other possibilities that may not have been included previously in any part of the project.

Finally, Chapter 7 will conclude all the findings, summarize recommendations, and provide ideas for further research.

2.2 Data Collection

This research will employ both qualitative and quantitative data collection methods consistent with the overall research methodology. The qualitative approach will primarily involve analyzing existing documents to understand the process map. To address gaps or incomplete parameters in the process map, interviews will be conducted with relevant stakeholders involved in the order-to-delivery process for the regional market. These interviews will provide deeper insights and a more comprehensive understanding of the process. Additionally, the interviews will facilitate the identification of key factors, which will be systematically analyzed using the cause-and-effect diagram. The literature review will further enrich the report's analysis, improvement, and control sections.

For the quantitative approach, data will be extracted from the company's inventory management system and supplemented by existing documents and tools utilized by the stakeholders to meet daily objectives in the regional market. This data will include crucial details such as order dates, product availability, loading times, and information on stock levels and demand forecasts. Such quantitative data will offer measurable support to the data insights. Other relevant quantitative data, including performance indicators, will be collected as secondary data (if available) or as primary data through interviews. The combined use of qualitative and quantitative data aims to identify areas for improvement, particularly in reducing lead time.

The collected data will be analyzed using a range of techniques. Qualitative data from interviews and process mapping will be subjected to context and content analysis to extract critical insights and factors related to the order-to-delivery process. Quantitative data will complement the root cause analysis and support the qualitative findings, with lead time information and other performance indicators (where available) helping to quantify potential issues within the current process.

2.2.1 Unit of Analysis and Sampling

The primary unit of analysis for the study is the supply chain functions within the anonymized paints and coatings company. The population comprises stakeholders involved in the order-to-delivery process for the regional market. For qualitative and quantitative research, a judgement sampling approach will be applied as the sampling strategy to ensure detailed knowledge from the stakeholders of the situation and context of the regional market.

Qualitative data, such as interviews, will be collected from the relevant stakeholders. The sample of respondents will be selected based on the researcher's judgment regarding who and whose information is most beneficial for the study. This strategy was chosen to obtain an in-depth understanding of specific information from the relevant stakeholders of the regional market.

The quantitative data for this study is sourced from the company's inventory management system. The project timeframe is limited to orders made in 2023, specifically from January 1, 2023, to December 31, 2023. This period is chosen assuming that all orders have been fully delivered, allowing for the calculation of the complete end-to-end lead time of the order-to-delivery process. The primary modules that collect data from the company's inventory management system include sales orders, outbound logistics, and material master data. Information fields across these modules are standardized and linked within the same file to ensure accuracy, while the customer's personal information is kept confidential.

2.3 Validity and Reliability

Validity will be assessed through triangulation, utilizing multiple data sources, such as literature, existing documents or reports, and validation from relevant stakeholders by presenting and discussing the research findings to cross-verify and validate the findings. Reliability will be ensured by comparing the data and information collected throughout the study, including process mapping, data extraction and processing, and the interview transcripts from relevant stakeholders, to confirm consistent results across different sources. Pre-determined questions will be posed to different stakeholders to address common objectives.

3 Background Study

Chapter 3 provides a comprehensive background study to enhance understanding of the problem through a literature review of relevant methodologies, principles, methods, and tools applied in this project. The chapter is organized into five (5) main sections: Section 3.1 explains the supply chain model, detailing the order-to-delivery process (Section 3.1.1) and highlighting the strategic importance of time as a key performance measure (Section 3.1.2). Section 3.2 discusses the Lean Six Sigma framework and its relevance to the project and Section 3.3 discusses the People, Process, and Performance (3P) framework to illustrate how these elements align with the project's objectives. Section 3.4 outlines the continuous improvement tools that will be utilized for the project. Section 3.5 introduces the concept of business process change management, which serves as an improvement reference for the project. Section 3.6 applies the background study to position the company within the theoretical supply chain model and value-cost advantage matrix, drawing insights from the literature review and brainstorming. Finally, Section 3.7 concludes the chapter with a summary of the results and areas to be discussed in the later stage.

3.1 Supply Chain Model

The global supply chain landscape has undergone significant shifts since the COVID-19 pandemic, signaling the end of the "business as usual" era. While the traditional ways of working may have provided comfort, value chain actors must now develop new capabilities promptly (Bain & Company, Inc., 2021).

Supply chain management is the concept of managing the upstream and downstream relationships with suppliers and customers to increase customer satisfaction with less cost. The public may perceive that logistics is the same as supply chain management, but supply chain management is a broader concept than logistics. Logistics focuses on a single plan of the flow of products and information through the business, and supply chain management focuses on the relationship between the stakeholders to gain more profitable outcomes throughout the whole chain (Christopher, 2011). Therefore, supply chain management can be seen as more strategic, and logistics can be seen as more technical. Moreover, supply chain management is geared towards creating value rather than successfully delivering the mission.

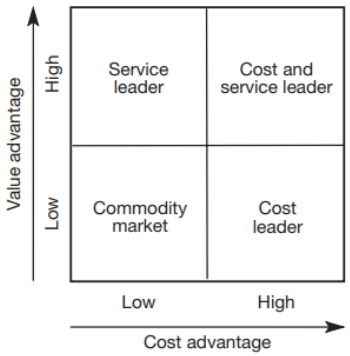

Figure 3 Company Position Based on Value Advantage and Cost Advantage (Christopher, 2011)

Figure 3 shows the value-cost advantage matrix. The goal of a successful business is to have the highest value advantage and cost advantage, which means high customer value with less cost. (Christopher, 2011). Being a cost leader or service leader is an excellent place to start, as it can focus on optimizing the other axis to move. Value advantage refers to the ability of the company to generate better value for its customers than its competitors. Cost advantage refers to the ability of the company to deliver goods at a lower cost than its competitor. In the matrix, value advantage can be decomposed into several influencing factors, which are from, but not limited to:

1. Benefit of the product or service (Christopher, 2011)
2. Product or service differentiation (Christopher, 2011).
3. Product or service quality (Kim & Mauborgne, 2005).
4. Customer experience (Kim & Mauborgne, 2005).
5. Value-added service (Christopher, 2011).
6. Brand strength and reputation (Christopher, 2011).

Moreover, cost advantages consist of several influencing factors, but not limited to:

1. Economies of scale (Christopher, 2011).
2. Efficient logistics, operations, and supply chain management (Christopher, 2011)
3. Lean processes and operational efficiency (Liker, 2004).

Therefore, the main challenge in managing the business is to identify appropriate supply chain management strategies to position the company in the top-right corner of the matrix, as shown in Figure 4.

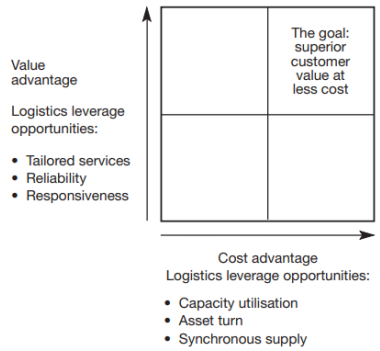

Figure 4 How to gain Competitive Advantage (Christopher, 2011)

From the integration evolution by Steven (1989), another important side is the changing competitive environment, which dictates the shift of importance of product excellence to process excellence. This does not mean that product excellence is not essential; instead, process excellence must be emphasized to help deliver more excellent customer value. As said by Christopher (Christopher, 2011), the equation visualization of competitive advantage will be

$$Competitive\ Advantage = Product\ Excellence\ x\ Process\ Excellence$$

Crafting the perfect combination of product and process excellence may lead to an outstanding competitive advantage for the company, as shown in Figure 5.

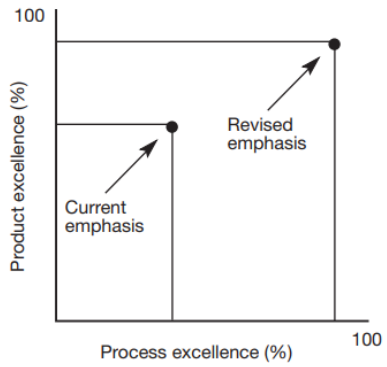

Figure 5 Visualization of Benefits by Investing in Product Excellence and Process Excellence (Christopher, 2011)

Figure 6 shows the evolution of supply chain integration by Stevens (1989), cited in Christopher (2011), suggests that a four-stage supply chain model that evolves from a functional independent department to supply chain integration between the suppliers, company, and customers (Christopher, 2011). Stage 1 shows how each department is somehow isolated from other business functions. Stage 2 shows that the department has a degree of integration between close-working functions. Stage 3 profoundly mandates establishing and implementing an internal end-to-end supply chain in the company. Stage 4 represents the optimum goal of supply chain integration, which extends Stage 3 towards the upstream with the supplier and downstream to the customer. Therefore, every company's supply chain goal is heading toward an integrated supply chain where the scope extends upstream to the suppliers and downstream to the customers (Knowles, Whicker, Femat, & Canales, 2005).

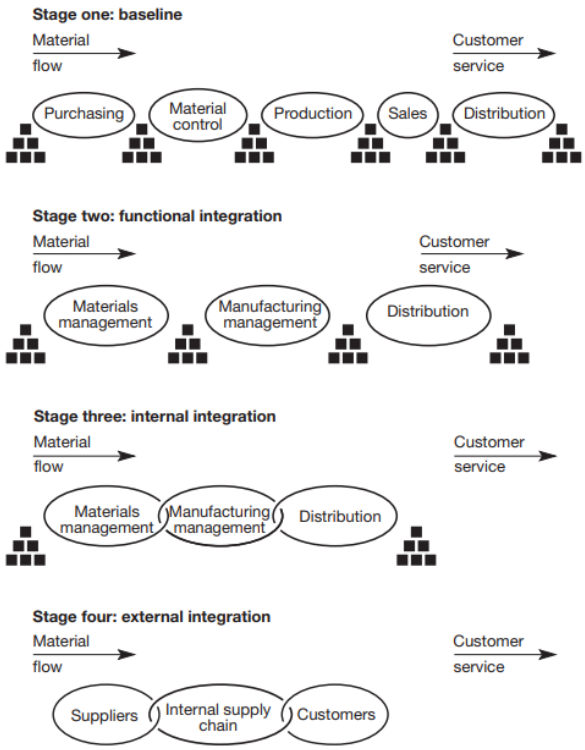

Figure 6 Evolution of Supply Chain Integration (Stevens, 1989)

Oberholzer-Gee's (2021) value-based strategy explains how a company can increase value creation, customer satisfaction, profit, and cost. The visualization of a value stick is shown in Figure 7 to create more value for a company by increasing the willingness to pay (WTP) and decreasing the willingness to sell (WTS)). Creating more value for the customer can be done through faster delivery time, better product quality, etc. Essentially, it is to add more value-added results to the customer. Value creation can also be done by lowering the willingness-to-sell (WTS) by creating a more enjoyable work environment that benefits the employees of a company. Keeping this in mind, the price and compensation, as well as the WTP and WTS, if set correctly, can simultaneously create more value and increase the company's profit (Oberholzer-Gee, 2021).

Figure 7 The Value Stick by Oberholzer-Gee (2021)

3.1.1 Lead Time in the Order-to-Delivery Process

The order-to-delivery process, from a customer's order entry to the receipt of the order, is the most critical and value-added process from the customer's perspective. It can be broken down into several vital phases: order entry and processing, order fulfilment, transportation, and order receipt. (Christopher, 2011).

Customer places order	Order entry	Order processing	Order assembly	Transport	Order received

Figure 8 Order-to-Delivery Cycle (Christopher, 2011)

Supply chain management calls for strategic decision-making, focus on satisfying end-customers, and effective performance measurement (PM) systems to achieve competitive advantage, meet customer needs, and improve quality. Responsive organizations can meet customer needs by designing all their processes and operations to improve response speed and reliability (Knowles, Whicker, Femat, & Canales, 2005).

Lead time, the duration from production initiation to final product delivery, is a critical metric in supply chain management, affecting operational efficiency and responsiveness (Kenton, Lead Time: Definition, How It Works, and Example, 2024). Customers in both industrial and consumer markets value shorter lead times, with industrial buyers seeking prompt fulfilment to meet specifications and consumers choosing readily available options due to substitutability (Christopher, 2011). High lead times can lead to customer dissatisfaction, lost sales, increased inventory costs, and inefficiencies, impacting profitability and market position. Reducing lead times through agile supply chain practices can enhance customer satisfaction, lower costs, and improve operational performance. For paints and coatings companies, this requires optimizing processes from raw material procurement to order fulfilment.

Short lead times in today's business environment provide a significant competitive advantage and increase customer satisfaction. Figure 9 shows the systematic visualization of how reducing lead times may minimize forecasting errors, leading to lower safety stock requirements, reducing the need for inventory, and resulting in cost savings. The longer the process is, the less responsive the system becomes to fluctuating demand. Extended lead times also diminish the visibility of demand, making it more challenging for manufacturing and procurement to align decisions with actual market needs (Christopher, 2011). Reduction of lead times in the process is equivalent to reducing waiting times or non-value-adding time between each process, as shown in Figure 10.

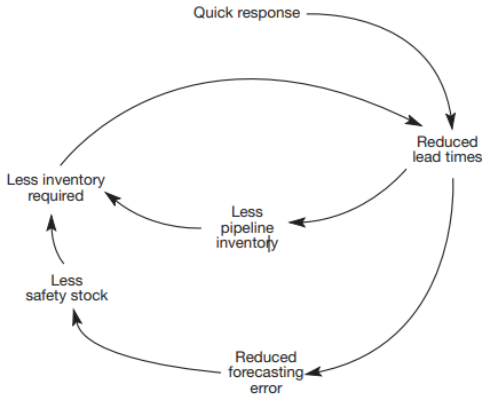

Figure 9 Reduction of lead times in the process leads to less cost (Christopher, 2011)

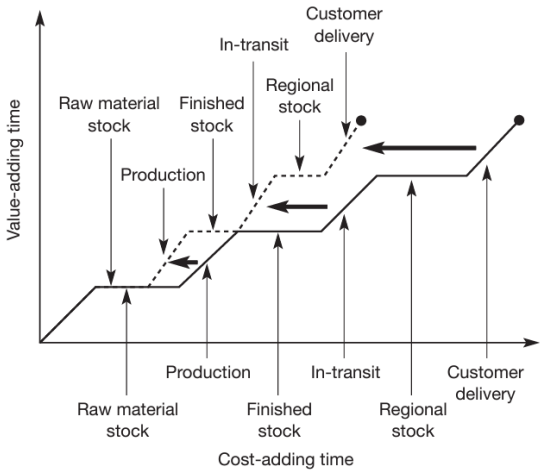

Figure 10 Reduction of Non-Value-Adding Time Improves Service and Reduces Cost based on Christopher (2011)

3.1.2 Strategic Importance of Time in Logistic Performance

Harrison and van Hoek (2011) underscore the strategic role of time in logistics performance. When one of the components is improved, the relationship between quality, cost, and service often involves trade-offs. Traditionally, achieving low cost and high quality simultaneously has been considered impossible due to perceived trade-offs. However, the authors argue that these trade-offs can be mitigated by implementing measures to prevent defects at their source. (Harrison & van Hoek, 2011). The key strategies include:

1. Designing error-proof processes to reduce the likelihood of defects.
2. Developing products that are easy to manufacture and distribute.
3. Providing comprehensive training for personnel to understand the processes and their limitations.

By focusing on preventive actions, companies can reduce overall quality costs, which include prevention, detection, and failure costs. Harrison and van Hoek (2011) further emphasize that improving quality does not necessarily lead to increased costs; optimizing processes can reduce both cost and lead times.

3.2 Lean Six Sigma's DMAIC Framework

Lean Six Sigma is guided by the principle of the "*define, measure, analyze, improve, and control"* (DMAIC) process, which is used to structure individual projects. This structured, result-oriented, and facts-based framework or approach to project management is a key component of Lean Six Sigma. (Knowles, Whicker, Femat, & Canales, 2005). DMAIC is a structured, result-oriented, and facts-based framework or approach to project management (Soković, Pavletić, & Kern-Pipan, 2010). As described by de Mast and Lokkerbol (2012), the DMAIC framework is an effective problem-solving methodology. (de Mast & Lokkerbol, 2012). The essence of DMAIC is having a structured process with an exploratory approach, which is a refinement of Deming's PDCA (Plan-Do-Check-Act) cycle. (Knowles, Whicker, Femat, & Canales, 2005).

The first phase (Define) is focused on understanding the process under investigation from the point of view of customers, suppliers, and operators. The second phase (Measure) seeks to measure current performance. The third phase (Analyze) analyzes contributors to poor performance and variation. The fourth phase (Improve) uses the outputs of the previous phases to define, test, and operationalize improvements. The final phase (Control) ensures that changes are embedded, successful, and, where appropriate, transferred to other processes.

Figure 12 shows the compilation of Six Sigma tools and techniques in the DMAIC framework cited by Knowles et al. (2005). These tools are further used in this project because they are believed to support each part of the DMAIC process effectively. Brainstorming, cause-and-effect diagrams, flow diagrams, histograms, Pareto charts, and a prioritization matrix will be used in the project.

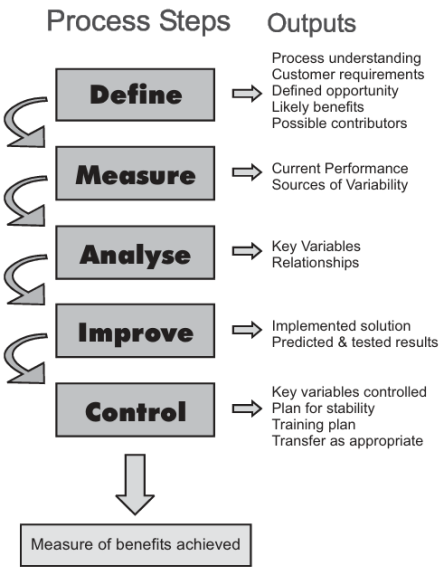

Figure 11 Six Sigma's DMAIC Framework, based on Knowles et al. (2005)

	D	M	A	I	C		D	M	A	I	C
Affinity diagram	♦		♦			Pareto chart		♦	♦	♦	
Brainstorming	♦		♦	♦		Planning tools (Gantt charts)				♦	
Business case	♦					Prioritisation matrix		♦		♦	
Cause-and-effect diagram			♦			Process capability		♦		♦	
Charter	♦					Process Sigma		♦		♦	
Consensus				♦		Quality control process chart					♦
Control charts		♦	♦	♦	♦	Regression			♦		
CTQ (critical-to-quality) tree	♦					Rolled throughout yield	♦				
Data collection formats		♦	♦	♦	♦	Sampling		♦	♦	♦	♦
Data collection plans		♦	♦	♦	♦	Scatter plots			♦		
DOE (design of experiments)			♦	♦		SIPOC diagram	♦				
Flow diagrams	♦	♦	♦	♦	♦	Stakeholder analysis	♦			♦	
Histogram/frequency plots		♦	♦	♦	♦	Standardisation					♦
FMEA		♦		♦		Stratification		♦	♦	♦	♦
Gage repeatability & reproduceability		♦				Stratified frequency plots			♦		
Hypothesis test			♦			Time series plots (run charts)		♦			
Kano model		♦				VOC (voice of the customer)	♦				

Figure 12 Six Sigma Tools and Techniques, from RSMC (2000); cited in Knowles et al. (2005)

Knowles et al. (2005) introduced "*The Supply Chain Conceptual Improvement Model* (SCCIM)," based on the DMAIC methodology, designed to address key supply chain challenges. It emphasizes aligning improvement activities with strategy, viewing the supply chain as a unified system, integrating actions across the supply chain, prioritizing the end customer, developing effective performance measurement systems, and incorporating variation reduction for optimal results.

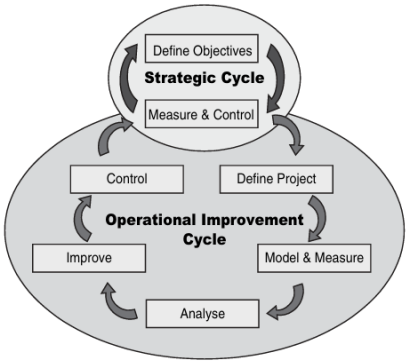

Figure 13 Supply Chain Conceptual Improvement Model by Knowles et al. (2005)

The strategic cycle of the SCCIM aligns the strategic goals with operational performance measures, creating a clear connection between actions and strategic direction. For the operational cycle, success at the project's outset requires agreeing on key stakeholders, defining resource allocation and benefit-sharing practices, securing commitment from all parties, and establishing a clear project scope. The "model and measure" stage involves creating an overarching view of the supply chain and breaking it down through detailed process mapping (Knowles, Whicker, Femat, & Canales, 2005).

The SCCIM model offers several benefits, including strong alignment with the organization's strategic objectives, proactive resolution of collaboration issues at the start, using Lean Six Sigma tools to eliminate non-value-added activities and reduce variation, and continuous improvement through feedback from strategic and operational cycles. Key factors for the successful implementation of this model include the influence and roles of key stakeholders, ethical information sharing, political support and acceptance of the methods, resource availability, and a well-defined cost-benefit analysis.

3.3 People, Process, Performance Framework

The People, Process, Performance (3P) framework is a framework introduced by one of the relevant stakeholders in the company. The “People” component tells us about the personnel's roles, responsibilities, accountability, culture, training, involvement, and ideas. The “Process” component is how things are done, which includes standards and service level agreements of each stage so that variation can be drawn out to give consistent output. Finally, the “Performance” component talks about the result of the process and people, which can be measured through lead times, KPIs, targets, etc. All these components in the framework are iterated into loops where data plays a role in every step of the iteration.

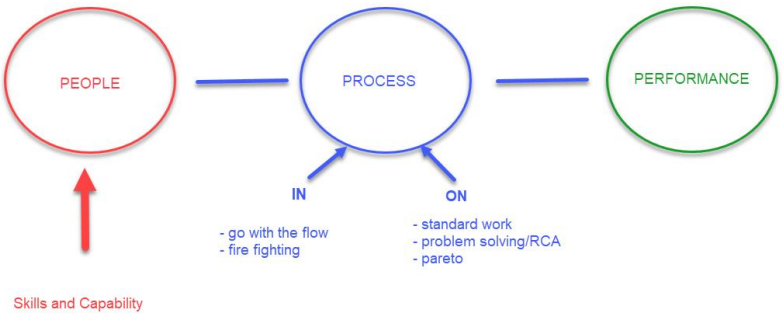

Figure 14 People, Process, Performance Framework

The 3P framework resembles the 4Ps of the Modern Marketing Management Framework by Kotler and Keller (2016), which includes people, processes, programs, and performance (Kotler & Keller, 2016). Perreault and McCarthy (2002) previously defined the Marketing Mix 4Ps as product, price, promotion, and place. Kotler and Keller (2016) introduced a holistic approach, updating the 4Ps to reflect modern marketing dynamics, emphasizing that marketing’s success depends on people within the organization and viewing consumers as individuals with unique perspectives. The "Process" involves creativity, discipline, and structured marketing management. "Programs" include consumer-focused activities that should be integrated to achieve firm objectives.

"Performance" encompasses financial and non-financial outcomes, extending beyond company gains. This adaptable framework can be applied across various company disciplines, aligning managers more closely with organizational goals (Perreault & McCarthy, 2002).

Figure 15 The Evolution of Marketing Management (Kotler & Keller, 2016)

Marketing involves activities that create, communicate, and deliver value to consumers, while the supply chain ensures the flow of information and materials that add value. The 3P framework can be applied similarly, correlating people, processes, and performance in supply chain management. Integrating technology into the 3P model could align with the "program" component in Kotler and Keller's 4Ps to enhance supply chain process improvement. Good performance does not always result from a good process, but poor performance is often due to flawed processes, aligning with Montier's process-outcome matrix (Montier, 2009). This highlights the importance of focusing on people and processes for improved performance. Effective processes arise from skilled, capable people who initiate, develop, and maintain them. Conversely, poor processes may stem from less skilled individuals. People are key to process change and need vision and strategic guidance from firm leadership to drive transformation. While the best process does not always ensure the best performance, lacking a good process almost guarantees suboptimal outcomes (Davenport & Redman, 2020).

	Good Outcome	Bad Outcome
Good Process	Deserved Success	Bad Break
Bad Process	Dumb Luck	Poetic Justice

Figure 16 Process vs Outcome Matrix (Montier, 2009)

Davenport and Redman (2020) analyzed digital transformation as relating to four (4) interrelated domains: technology, data, process, and organizational change capability. Poor performance from one of the domains may hamper a properly designed transformation plan. As important as the process, it all comes down to the quality of the people, and people need to be guided on a vision and strategy to move. Assembling the right team of technology, data, and process people who can work with a strong leader to lead the change. The best talent does not guarantee success, but a lack of it almost guarantees failure (Davenport & Redman, 2020).

3.4 Utilizing Continuous Improvement Tools

This section will discuss the various continuous improvement tools that will be used in the sections of the report. The tools discussed in this section are process mapping, cause-and-effect diagram, SWOT analysis, Pareto analysis, Cost-Benefit Analysis, and Coding. Each tool will be

further discussed with the relevant literature to the project approach and how it will be used to measure the current situation, as-is analysis, and improvement solution in the following.

Process Mapping

The process map is one of the critical tools used in continuous improvement efforts. Process mapping is crucial in understanding the order-to-delivery process, serving as a foundational step for process re-engineering. Flowcharting the supply chain processes is essential for identifying opportunities for improvement, especially in differentiating value-added from non-value-added activities (Christopher, 2011).

In the planning phase of process mapping, additional elements can be integrated to ensure sustainable assets are considered for continuous improvement. However, many organizations fail to effectively manage the flow of materials and information from suppliers to customers, resulting in missed opportunities for efficiency gains. A lack of visibility across the entire supply chain further compounds this issue, preventing departments from recognizing potential areas for lead time reduction (Christopher, 2011). A supply chain map is an effective tool for offering a time-based view of the processes, making the supply chain more transparent and exposing areas for improvement.

The process map method will be used to determine the order-to-delivery activities. The result of the process map can be seen in Section 4.2.

Cause-and-Effect Diagram

The cause-and-effect diagram is famously promoted by Kaoru Ishikawa as a quality control tool in the Japanese manufacturing industry to identify potential factors causing the observed effect. Coccia (2017) used a cause-and-effect diagram as a visual representation to identify the potential root causes of the evolution of technological innovations for an appropriate technology management tool known as general-purpose technologies (GPTs) (Coccia, 2017).

The causes used by Coccia (2017) are not strictly the commonly known 6M's in the manufacturing industry or 7P's in the marketing sector; the study uses literature to obtain the possible causes or drivers that are believed to be the source and evolution of significant innovations. However, most cause-and-effects diagrams follow the convention of the 5M1E's primary causes format (Man, Machine, Material, Method, Measurement, and Environment) or 6M's (Man, Materials, Machine, Method, Measurement, and Mother Nature), which enhances clarity and straight-forwardness in the problem-solving process (Siwiec & Pacana, 2021). According to Mahto and Kumar (2008), the cause-and-effect diagram can also help to trace the direct cause of a problem in manufacturing processes (Mahto & Kumar, 2008).

A cause-and-effect diagram will be used to summarize the qualitative findings together with the interview result and coding approach in Section 5.3.

SWOT Analysis

A SWOT or Strength, Weakness, Opportunity, and Threats Analysis can be used. SWOT analysis is a tool to evaluate the internal and external environment of a company in a strategic analysis (Štěrbová, Loučanová, Paluš, Ivan, & Šálka, 2016). Helms and Nixon (2010) state that SWOT analysis is a common planning tool among practitioners, researchers, and students in business

and strategy to assess alternative and complex decision situations involving a subject's internal and external issues.

The objective of SWOT is to utilize qualitative data for explanatory approaches and to generalize findings from respondents or observations into groups of critical themes, which are known as the Strengths and Weaknesses of internal factors and Opportunities and Threats of external factors (Helms & Nixon, 2010).

SWOT analysis will be used to obtain the possibility and liabilities of the assets and environment of the company, which is utilized in Section 3.6 and Section 6.2.1.

Pareto analysis

Pareto Analysis, originating from the work of economist Vilfredo Pareto, is an effective tool for the use of decision-making and optimization across fields such as supply chain management (Talib, Hamid, & Thoo, 2015). The fundamental of Pareto principles is the 80/20 rule, which is elaborated as the 80% effect comes from the 20% of causes (Gamberini, et al., 2022) The Pareto analysis is a versatile and capable tool. Its principal aim is to focus on 20% of products that generate 80% of sales.

Pareto analysis will scope the most beneficially impacting objects/subjects to the analysis. The method is applied in Section 4.1.2 and Section 5.1.1.

Cost-Benefit Analysis

Pettersson and Segerstedt (2013) described how to measure supply chain cost to understand better a company's supply chain efficiency (Pettersson & Segerstedt, 2013). A study by Dorfhuber et al. (2020) discusses cost-benefit analysis in state and local governments to improve their region to survive a pandemic in the short- and long-term that led to the use of a benefit and ease of implementation matrix (Dorfhuber, O'Leary, & Agarwal, 2020).

A cost-benefit analysis will be used to map the feasibility of the solution based on the cost and benefit principles. The method is applied in Section 6.2.2.

Coding

Coding is a qualitative data analysis strategy that labels a text on a qualitative data source with a code or concept. Essentially, coding is mapping qualitative data sources to provide an overview of individual data or concepts that allow a researcher to grasp the relation of the codes to the defined research questions (Elliott, 2018). Linneberg and Korsgaard (2019) state that coding is an essential tool in translating raw quantitative data into a communicative and trustworthy “story”. Coding summarizes essential context words from a large amount of empirical quantitative material (Linneberg & Korsgaard, 2019).

Coding will be used to summarize the qualitative findings in the interview result for process mapping, in collaboration with the SWOT analysis and cause-and-effect diagram. The method will be used indirectly in Section 5.3.

3.5 Business Process Change Management

Change management is a structured process for managing, planning, and implementing changes or new ways of operating in an organization (Miranda, Bottorff, & Watts, 2022). According to Kettinger and Grover (1995), Business process change management is defined as the strategy-driven organizational initiative to improve and (re)design business processes to achieve competitive advantage in performance through changes in the relationships between management, information, technology, organizational structure, and people (Kettinger & Grover, 1995). Kettinger and Grover (1995) proposed a theoretical framework for business process change management that outlines the interrelated effects of change environment, business process change management, change outcomes, customer success, and measurable performance gains.

From, it is proposed some broad propositions by Kettinger and Grover (1995) where:

1. Proposition 1: Creating an environment conducive to change requires strategic initiatives, effective knowledge sharing, continuous learning, balanced network relationships, and a culture that is open to change.
2. Proposition 2: A culture that promotes knowledge sharing, learning, and balanced network relationships supports strong process management and effective change management practices.
3. Proposition 3: Effective business processes and change management practices lead to successful business process changes and enhance the quality of employees' work lives.
4. Proposition 4: Organizations that enhance their business processes and services while empowering and satisfying employees are more likely to achieve higher customer satisfaction and success.
5. Proposition 5: Organizations that satisfy their customers and contribute to their success are likely to see improved financial performance.

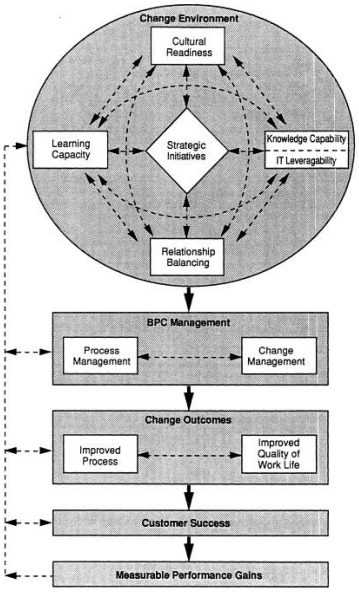

Figure 17 A Proposed Framework for Business Process Change Management (Kettinger & Grover, 1995)

A systematic approach is crucial to simultaneously improving cost, quality, and time measures. Harrison and van Hoek (2011) emphasize the importance of addressing root causes rather than symptoms. Their time-based process improvement methodology includes:

1. Understanding customer responsiveness needs.
2. Recognizing the need for change.
3. Gaining a thorough understanding of current processes.
4. Identifying unnecessary steps and wasted time.
5. Addressing the root causes of inefficiencies.
6. Implementing process changes.
7. Reviewing and refining the improvements.

Iacoviello et al. (2024) mentioned about the general best practices for change management includes (Iacoviello, Whiteford, & Downie, 2024):

1. Clearly define the vision and make goals measurable.
2. Ensure employee buy-in is as important as executive sponsorship.
3. Be willing to adjust your process, especially if it is not driving the coveted outcomes.
4. Engage employees in decision-making when necessary.
5. Collaborating with functional processes leads to the useability and automation of processes.
6. Create your change management plan based on organizational risk tolerance.

Also, an important aspect that overlaps with the 3P framework is people. To determine the necessary stakeholders in the change management process, the team would need to:

1. Define the scope of change
2. Determine who consistently uses and operates these current processes
3. Engage those stakeholders initially; along the progress, you might find more key stakeholders to consider
4. Be flexible with adjusting your change management processes

The goal is to have visibility of the process with an essential amount of information and detail. Christopher (2011) mentioned an illustrative form of visibility through an end-to-end view and measurement of a supply chain shown in Figure 18. Having the right process map and the right amount and data quality can facilitate further preventive and curative actions.

Many companies have invested in reducing lead time, such as introducing automation in the factory. However, the real question is, "*Does it solve the root cause of the problem?*". Some cases show that even if automation is already applied, it does not significantly improve the process. Key actions to take are to look across the different stages in the end-to-end supply chain and at how time as a whole process can be introduced, either by re-engineering the chain structure or simply with a few adjustments along the way. In many cases, the opportunity to reduce lead time can often be through simple changes in procedure (Christopher, 2011).

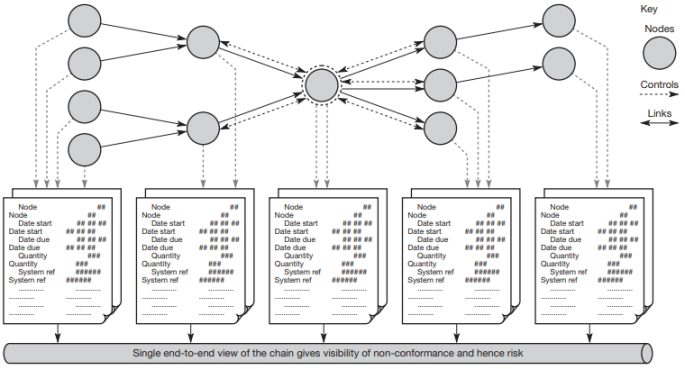

Figure 18 End-to-end view of a supply chain, represented with nodes and links (Christopher, 2011)

3.6 Company's Relative Position to the Supply Chain Model

After the relevant theories and concepts were discussed in earlier chapters, direct application was conducted to assess the company's position relative to the literature. The supply chain model outlined in Section 3.1 and the SWOT analysis described in Section 3.4 were applied for this purpose.

The company's confidential annual report approximated its relative position in the supply chain model. As outlined in the report, insights regarding goals, annual performance, and near-term strategic plans were inferred for further evaluation. The SWOT analysis categorizes this information as strengths, weaknesses, opportunities, or threats. While the detailed results of the SWOT analysis remain undisclosed due to confidentiality, judgments regarding whether the information contributes to a positive or negative value or cost advantage were made based on disclosed analyses and brainstorming efforts. A general illustration of the company's position in the supply chain model, referenced in Figure 3, is presented in Figure 19.

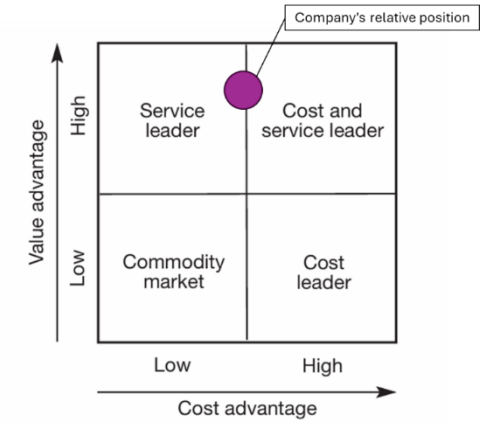

Figure 19 The company's relative position to the value-cost advantage matrix.

The analysis highlights the company's strong position in delivering value, driven by its focus on profitable growth through innovative, high-performance, and sustainable products. A leading presence in premium market segments has been established, with promising opportunities in mid-market segments being effectively pursued. The company's commitment to service levels, customer satisfaction, and employee experience has further reinforced its reputation. High product quality and a loyal customer base across diverse markets and product segments

underscore its strength. Adherence to sustainability and regulatory compliance has also solidified its standing as a leader in innovation, particularly in sustainable product solutions.

In addressing broader industry challenges, the company has prioritized enhancing cost efficiency. Efforts have included streamlining operating expenses in non-core areas, innovating supply chain processes to achieve greater efficiency, and focusing on operational quality and performance. These measures are designed to address the increasing market demand for cost-competitive solutions while maintaining excellence in value creation.

In conclusion, while the company continues to excel in creating value through innovation and sustainability, strategic initiatives have been implemented to address cost optimization—an industry focus area. This includes improving supply chain management and refining the order-to-delivery process to reduce lead times and improve performance. These efforts aim to position the company as a balanced leader in both value creation and cost efficiency, ensuring sustainable growth and maintaining a competitive edge in a dynamic market environment.

3.7 Sub-Conclusion of Chapter 3

This chapter provided a background study on existing theories, methodologies, tools, and principles and their application to real-life cases. It covered the supply chain model and how companies compete for superior value and cost advantage to achieve a competitive edge. Time was emphasized as a strategic performance metric, showing how reducing lead times can boost customer satisfaction and operational efficiency. The chapter also discussed Lean Six Sigma and continuous improvement frameworks like the DMAIC and 3P frameworks, which offer structured approaches focused on people, processes, and performance. The significance of change management practices was highlighted, emphasizing strategic initiatives, knowledge sharing, and stakeholder engagement to support sustainable business transformation.

The findings positioned the company within the value-cost advantage matrix, indicating that while it excels in value creation, efforts are needed to strengthen cost competitiveness. This underpins the need to refine supply chain management and improve the order-to-delivery process to reduce lead times and enhance performance. Chapter 4 will describe the findings of the current state of the order-to-delivery process.

4 Current Situation of the Order-to-Delivery Process

Chapter 4 measures and maps the current situation of the order-to-delivery process. The chapter is structured into four (4) main sections: Section 4.1 evaluates the lead time performance of the current order-to-delivery process, including data analysis and transformation using MS Excel Power Query and Pivot Table. This section also details the lead time data modeling (Section 4.1.1), customer segmentation based on valuation (Section 4.1.2), and presents the findings and distribution of the lead time (Section 4.1.3). Section 4.2 provides the process maps of the order-to-delivery process using BPMN diagram, starting with an overview of the company's operating model for initial reference (Section 4.2.1) and detailing the sales order entry process (Section 4.2.2), sales order processing process (Section 4.2.3), and order fulfilment process (Section 4.2.4). Section 4.3 discusses the scope and limitations of data collection under current conditions. Section 4.4 concludes the chapter with a summary of the results and topics for further discussion.

4.1 Lead Time of the Current Order-to-Delivery Process

This section will collect and discuss the lead time of the current order-to-delivery process. Section 4.1.1 will discuss how the lead time data modeling is conducted. Using the extraction method from the company's inventory management system, relevant data may be obtained and used for further analysis. Section 4.1.2 describes the scoping down process from the large datasets obtained from the company's inventory management system. The project focuses on the valuation nominal of the regional market. Section 4.1.3 elaborates the findings as a continuation from the valuation to obtain which part of the data was an opportunity to improve. The output of this section will be further analyzed in Chapter 5 as part of the root cause analysis of the project.

4.1.1 Quantitative Data Modelling

To model the data, lead time is defined based on the context of this research. In this project, lead time is measured from when the sales order is entered into the system (Order Date) to when the order is ready for shipment but not yet transported by third-party logistics (Goods Issue Date). Figure 20 shows the activities, and the date is represented for each activity.

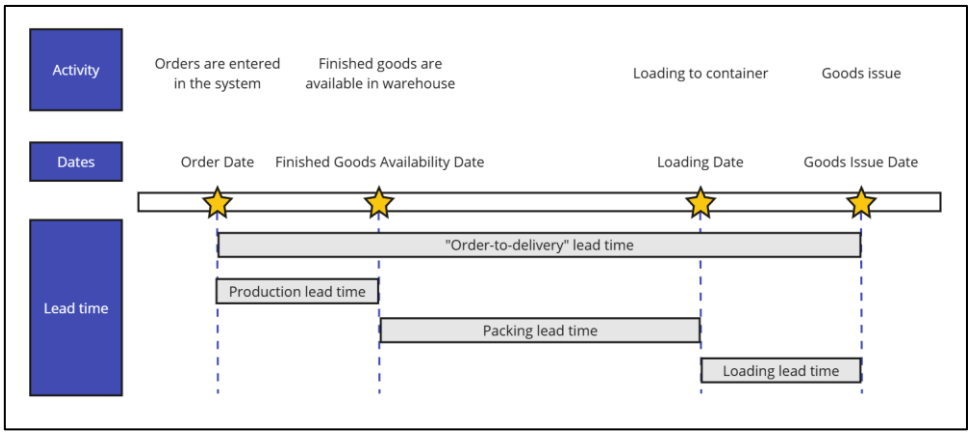

Figure 20 Process, Date, and Lead Time Definition

This scope is chosen to focus on internal process improvements and avoid the added complexity of third-party logistics. The lead time equation for the order-to-delivery process is defined as:

Order-to-Delivery Lead time = Goods Issue Date – Order Date

Next, the relevant data for this project will be extracted. The data collection focuses on the targeted regional market data, and products are only sent from the production facility in Europe. For the analysis, only data related to regional market customers will be examined, and the location and the customer's name will be kept confidential.

Data extraction from the company's inventory management system involves three (3) key modules and an additional offline archived dataset:

1. **Customer Data**: This dataset identifies specific customer information with essential customer numbers for filtering the datasets.
2. **Sales Order Data**: This dataset provides information on sales orders, including sales document numbers, material details, order quantities, and relevant dates. It will be used in comparative analyses with outbound logistics and material master data.
3. **Outbound Logistics Data**: This dataset provides outbound information from the logistics side of the order-to-delivery process, detailing the flow of finished goods from production to storage and shipment. It includes delivery-related information, such as document numbers, confirmed quantities, and important dates, and is part of the comparative analysis.
4. **Material Master Data**: This dataset provides detailed product information, including material codes, descriptions, standard costs, and planning indicators. It complements the comparative analysis with sales orders and outbound logistics data.

After defining what datasets are needed, the data modeling for lead time assessment is procedurally explained in the following steps:

1. **Merging dataset by concatenating technique**: Using Power Query and concatenation techniques, all four datasets are merged to create a comprehensive overview of lead time data, ensuring data completeness across relevant departments.
    1. Output: Merged Sales Order Data, Outbound Logistic Data, Material Master Data, and Customer Data.
    2. Triangulation is achieved as the data from multiple quantitative sources is valid and reliable.
2. **Valuation**: The data is narrowed down using Pivot Tables to focus on relevant results and impacts.
    1. Output: Customer-focused data for deeper analysis, elaborated in Section 4.1.2.
3. **Lead Time**: The merged data is analyzed to extract lead times for the selected customers.
    1. Output: Lead time data specific to customers, detailed in Section 4.1.3.
4. **Lead Time Over 31 Days:** Data is filtered to identify orders exceeding a 31-day lead time, per the sales support team's service level agreement (SLA) information.
    1. Output: Document numbers, material descriptions, and quantities for orders surpassing 31 days.
5. **Scoped Products**: Using Pivot Tables, data on items with extended lead times is analyzed, focusing on made-to-order (MTO) and made-to-stock (MTS) items.

6. **Priority**: Products are prioritized based on their contribution to the total confirmed quantity and the potential for process improvement:

This data modeling process results in a list of products for further investigation in Chapter 5.1.

4.1.2 Scoping Based on the Valuation Data

This section shows the current situation of the valuation data from the data modeling. Figure 21 shows the valuation of sales by all the regional market customers in 2023. Figure 22 shows the sales valuation made by the regional market customers through the company's "City A" office in 2023. Due to the confidentiality agreement, the information in Figure 21 and Figure 22 are not shared publicly.

Based on the findings, the project will focus on customers with sales made through the company's "City A" office because sales valuation of approximately 65% of the overall specialized product's value in the regional market for 2023 compared to the total valuation of sales to all customers in the regional market.

Figure 21 Valuation of Net Sales Value for the Regional Market Customer in 2023

Figure 22 Scoped Customer Valuation of Net Sales Value

4.1.3 Lead Time Calculation

The “Lead Time” dataset includes more than 3,000 order lines, with lead time ranging from less than 10 days to almost 500 days. The average lead time is approximately 54 days. The sales support team (SS) service level agreement (SLA) for delivery, excluding shipping and feeder lead time to the regional market, is 31 days (or approximately four weeks). Consequently, further analysis focuses on orders exceeding this 31-day threshold.

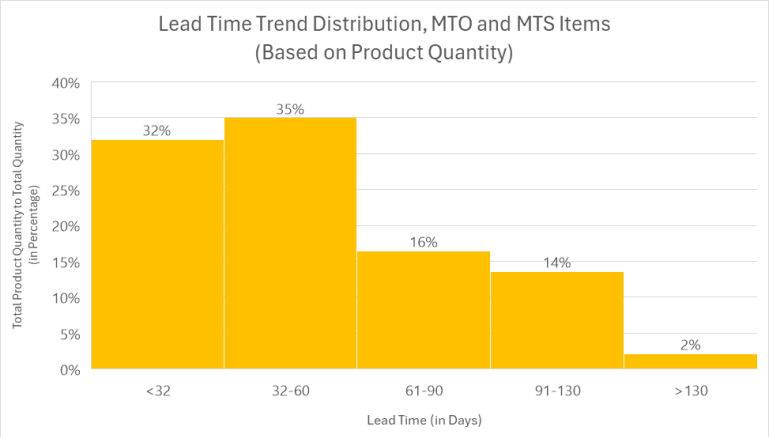

Figure 23 Lead Time Trend Distribution, MTO and MTS Items

Figure 23 illustrates the lead time trend distribution for all made-to-order (MTO) and made-to-stock (MTS) items in trend distribution and percentage. Specific values of the product quantity are disclosed due to confidentiality reasons. Based on the total product quantity, which is disclosed, 32% were delivered on-time within 31 days. However, 67% of the total products exceeded the SLA, with 35% being delivered within 32-60 days, 16% within 61-90 days, 14% within 91-130 days, and 2% taking over 130 days.

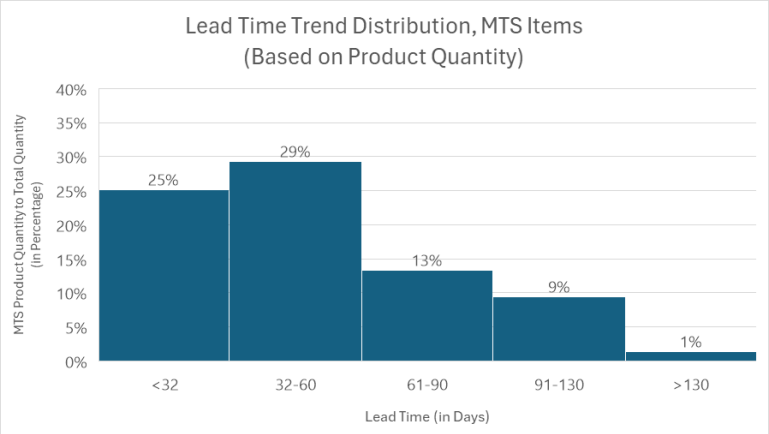

Figure 24 Lead Time Trend Distribution, MTS Items

Figure 24 shows the trend distribution for MTS items, within the total product items ordered (MTO and MTS). 25% of the MTS items were delivered on-time, while 68% exceeded the SLA, including 29% within 32-60 days, 13% within 61-90 days, 9% within 91-130 days, and 1% are over 130 days.

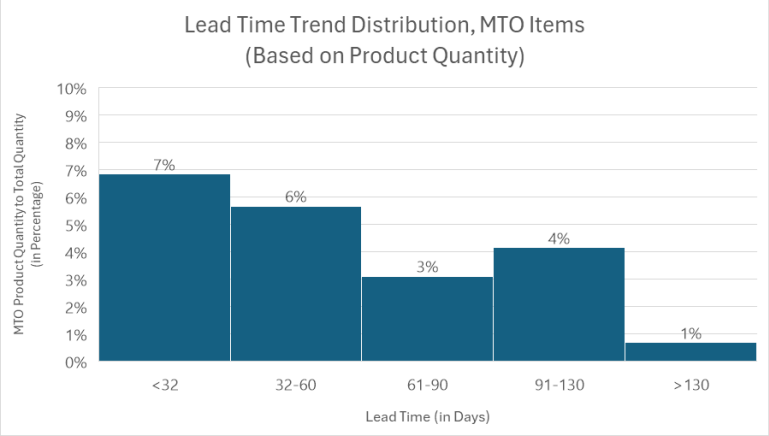

Figure 25 Lead Time Trend Distribution, MTO Items

Figure 25 shows the trend distribution for MTO items, within the total product items ordered (MTO and MTS). 7% of the MTO items were delivered on-time, while 14% exceeded the SLA, including 6% within 32-60 days, 3% within 61-90 days, 4% within 91-130 days, and 1% are over 130 days.

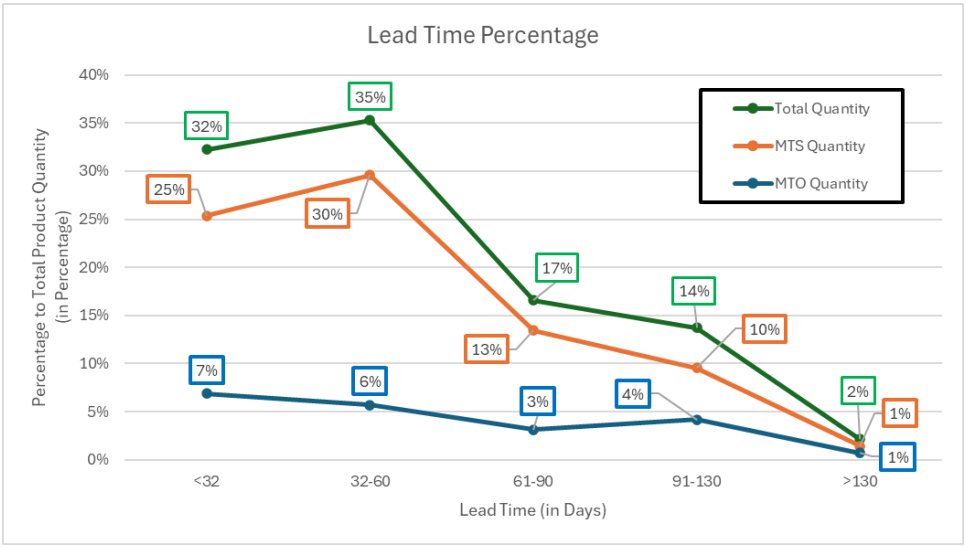

Figure 26 Comparison of MTO and MTS Items in Percentage to the Total Product Quantity

Figure 26 compares the contribution of MTO and MTS items as percentages of the total ordered products. MTS items account for nearly 80% of the total, with 25% delivered on-time and over 54% delayed. MTO items constitute 20% of the total, with 7% on-time and 14% delayed relative to the overall quantity.

The findings reveal that the average lead time of 54 days and potentially extends to 90-130 days or more. Based on discussions with the company, it is suggested that the focus be on improving the MTO items because MTO items present more challenges due to the lack of demand forecasting. MTO items production is initiated only when an order is received. In contrast, MTS items benefit from safety stock, demand forecasting, and scheduled replenishment cycles, ensuring more controlled lead times.

The goal is to reduce lead times for MTO products to avoid products becoming slow-moving or obsolete (SLOB) upon arrival, maintaining customer satisfaction and product viability. The critical

factors influencing MTO planning strategies include regional consumption levels and product shelf life. In contrast, MTS items, with their existing forecasting and safety stock mechanisms, are less of a focus for this project.

4.2 Process Mapping of the Order-to-Delivery Process

4.2.1 Preliminary Background of the Process Map

This section presents a process map to help understand the order-to-delivery process and the associated administrative lead time, which will be analyzed further in Chapter 5 as part of the root cause analysis. The process map follows the Business Process Model and Notation (BPMN) format with swim lanes to outline each stakeholder's responsibilities. Additionally, the map highlights the documents used as inputs and outputs throughout the process. Certain activities are grouped in the BPMN to show lead times as aggregates of these activities.

Figure 27 illustrates the company's operating model, showing a high-level view of how different functions interact. From this model, the focus is narrowed to "Process X", which is central to understanding the order-to-delivery process. The company's operating model is black-boxed due to confidentiality reasons.

Figure 28 presents the Value-Added Chain Diagram (VACD) of the "Process X" process, providing a more detailed breakdown of how an order is managed. The BPMN map further specifies the activities and stakeholders involved in each sub-process. The "Process X" process is black-boxed due to confidentiality reasons.

The "Process X" process begins with gathering prerequisite information from commercial master data and pricing management before sales order entry. This data helps the company and customers understand product status, availability, and pricing. Once the order is entered, the sales order processing phase begins. The input from sales order information is passed into production through replenishment orders and further planning purposes. The order fulfilment phase involves coordinating the shipment of finished goods to ensure legal and logistical compliance. This phase includes coordination with third-party logistics providers for land, sea, and further transportation to the customer. Finally, the invoicing is completed to ensure accountability and provide proof of order fulfilment, allowing the company to collect payment and continue operations, maintaining customer satisfaction.

The specific process for the regional market was not previously mapped in the company's repositories. However, an initial flowchart was created by the stakeholders involved in the regional market operations. This flowchart was refined into a BPMN diagram, identifying the stakeholders and activities involved. Interviews were conducted to measure lead times, verify activities, and confirm the documents used as inputs and outputs to understand the process comprehensively. Figure 27 and Figure 28 act as references Figure 29 to Figure 32.

Figure 27 Company Operating Model

Figure 28 Value-Added Chain Diagram (VACD) of "Process X"

4.2.2 Sales Order Entry Process

Figure 29 illustrates the sales order entry process using a BPMN diagram. This process begins when the customer service team at the regional market office (CS RM) receives an order from a customer or distributor. A team member inputs the order into the regional market plant's inventory management system (System B) and converts it into the production facility in Europe's inventory management system (System A) codes, as the systems differ. Once converted, the team member compiles the order details in a spreadsheet and sends it via email to the sales support team (SS) in the production facility in Europe. This step is typically completed within one day.

At the production facility, the sales support team monitors the designated email inbox for incoming orders. The orders are processed using an automated delivery date procedure within the system. A team member then enters the order into the central inventory management system and, if necessary, consults relevant internal stakeholders to confirm whether the order can be fulfilled in full, partially, or not at all due to item unavailability. A confirmation is sent back to the regional office for orders with unavailable items, excluding those items.

Order confirmations are provided in both digital and physical formats and include details such as item availability and expected delivery dates, indicating whether the order is complete, partial, or has unavailable items. This process follows an informal service-level guideline, based on operational experience, aiming for delivery within four weeks from the initial order entry. Occasionally, other internal stakeholders may request order confirmations for their processes, although no formal procedure specifies who is entitled to receive them.

The sales support team generally takes one day or less to process an order from the time it is received to the issuance of the order confirmation. Overall, the sales order entry process—from the regional team's input in System B to the return of the order confirmation—typically takes about two days, with one day allocated for each team's tasks.

This process ensures that regional market customer orders are entered into System A and prepared for subsequent steps, including stock allocation, production scheduling, delivery planning, container arrangements, administrative tasks, invoicing, and more.

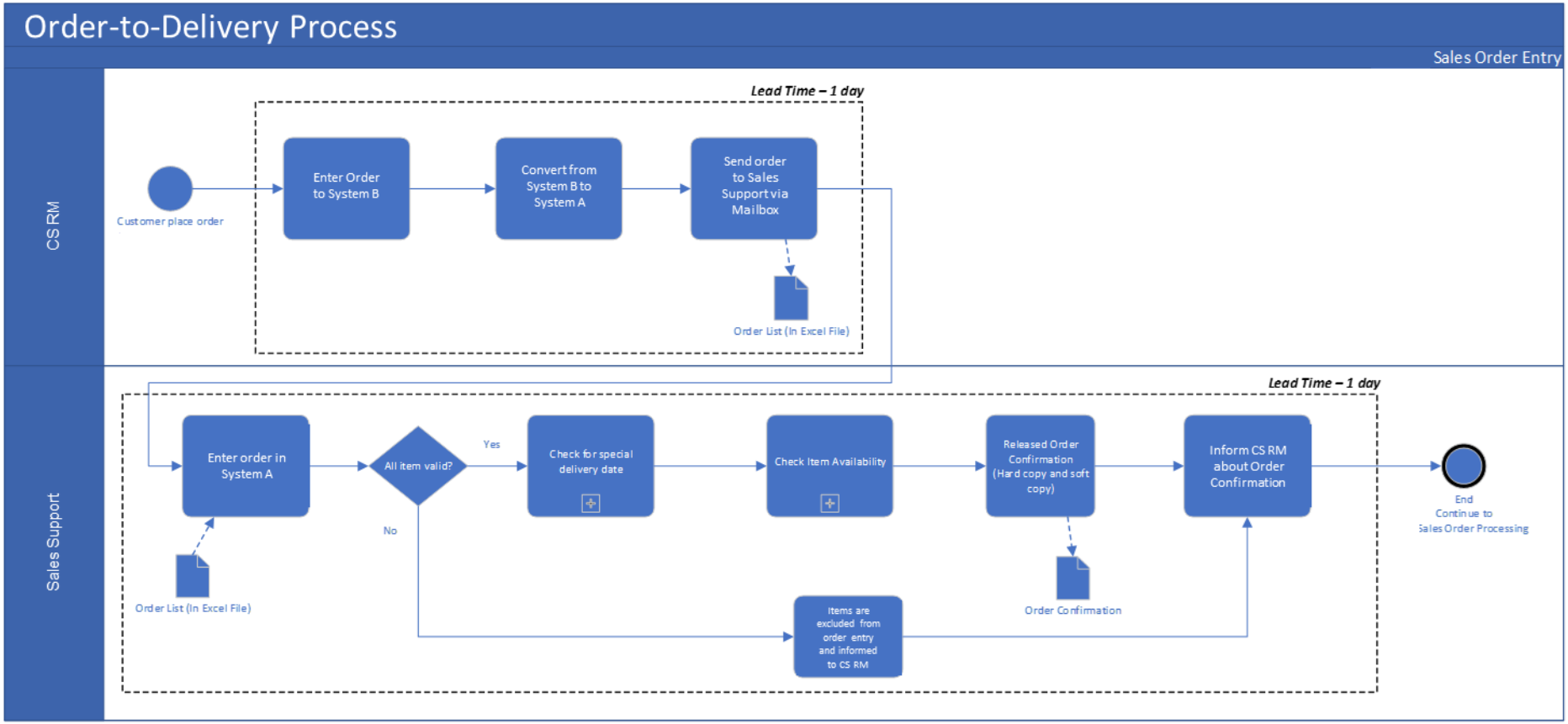

Figure 29 BPMN Diagram of the Sales Order Entry Process

4.2.3 Sales Order Processing Process

Figure 30 illustrates the progression from sales order entry to sales order processing. Once order details are entered into the system, they are utilized by planning, production, and demand planning teams, as shown in Figure 28. This research primarily focuses on the coordination role of the sales support team (SS) with other teams, particularly the logistics team (LOG). While the planning and production processes are acknowledged, they are assumed to operate effectively and are outside the primary scope of this study. The SS's primary responsibility in this context is to liaise with LOG for container booking and shipment to ensure the delivery of finished goods to customers.

The process begins with the SS sending a container request email to LOG, including order details and container size specifications (e.g., 20-foot or 40-foot) based on the order volume. For customers in certain regions, delivery follows an automated date selection to ensure timely shipping.

A key risk in this process is human error arising from manual data entry. Issues such as typographical mistakes or missed communications can disrupt the workflow, leading to errors in order quantities or delays in processing. For instance, a typo could inflate an order from 3,000 kg to 30,000 kg, or an overlooked email could delay handling, necessitating urgent container arrangements to maintain the delivery schedule. Container shortages add further complexity, potentially delaying shipments.

Once the SS submits a container request, LOG processes it and coordinates with a shipping agent. The lead time for container booking confirmation from the shipping agent ranges from 1 to 14 days, as shipments to customers with automated delivery schedules are conducted bi-weekly and are subject to external logistics conditions. Orders that do not meet the minimum for a full container load may be deferred to the next available shipment. Recent global container shortages have exacerbated these delays.

The shipping booking confirmation, issued after container booking, includes critical details such as vessel name, estimated time of shipping (ETS), estimated time of arrival (ETA), container size, order line count, and total weight. Once LOG receives this confirmation, they relay the details to SS, who then updates the customer service team at the regional office. Typically, the lead time for SS to forward this information to customer service is less than one day.

Meanwhile, the planning, production, and demand planning teams operate concurrently to manufacture the goods. Once finished goods are transferred from the production plant to the shipping warehouse, the process transitions to the order fulfillment stage (see Section 4.2.4).

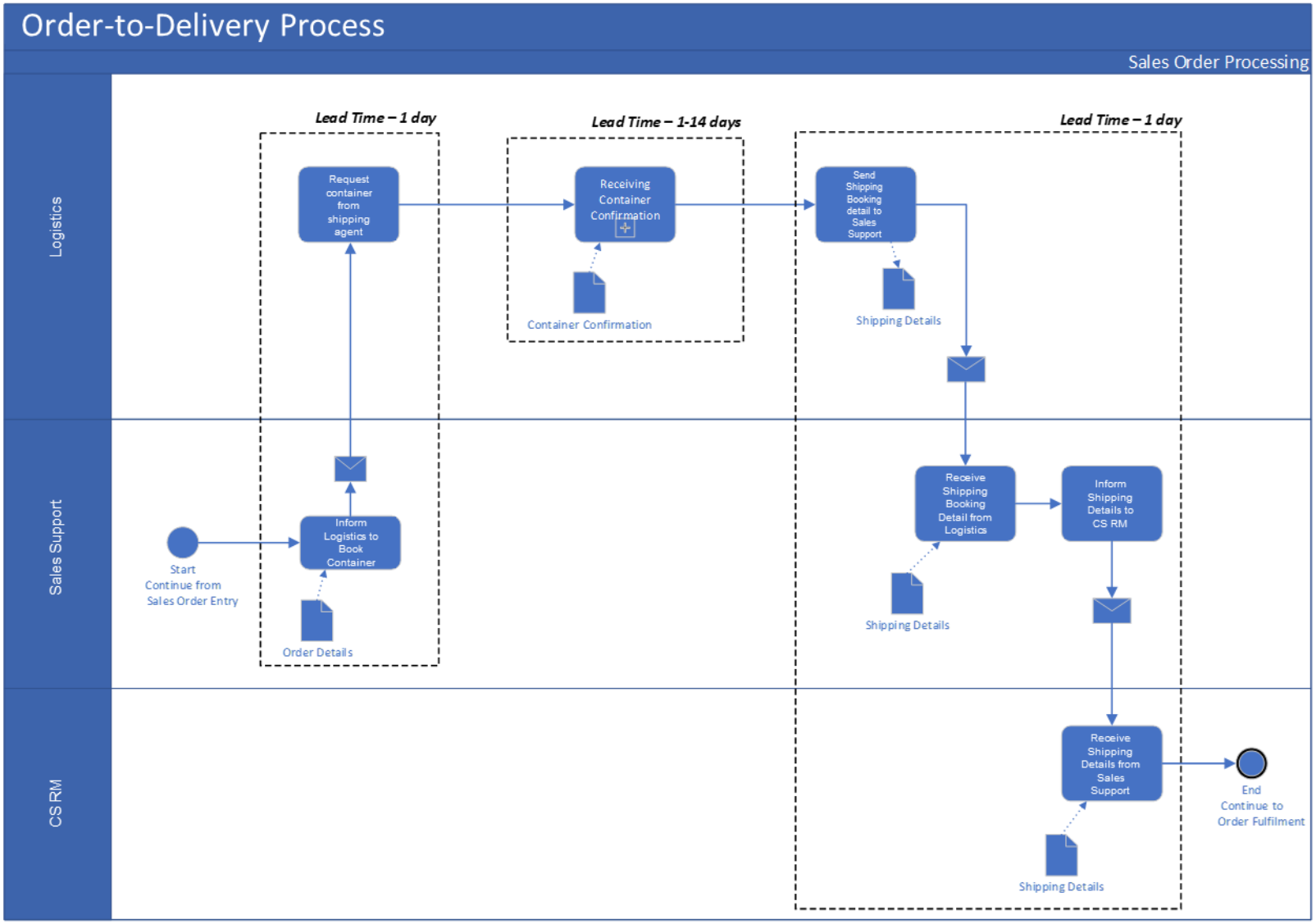

Figure 30 BPMN Diagram of the Sales Order Processing Process

4.2.4 Order Fulfilment Process

The order fulfillment process, illustrated in Figure 31, begins when the production team completes manufacturing and transfers finished goods to the logistics warehouse for shipping preparation. The logistics team conducts a final selection of products based on customer orders. At this stage, a preliminary delivery note is created, but the products remain unpicked and unpacked. The packing process, which involves retrieving items from storage and arranging them on pallets, usually takes 1-2 days, with most items ready two days before loading. During the loading phase, the final delivery note and the packing list and customer invoice are issued. The overall lead time for product selection and delivery preparation is approximately 5-6 days

The logistics team then arranges for the products to be dispatched to their destination using a combination of trucking and sea transport. For urgent or express shipments, airfreight may be used in collaboration with third-party logistics providers. Documents prepared by the logistics team are forwarded to the sales support team (SS), which creates the required paperwork for regional market customers. This process, involving third-party coordination, can take anywhere from 2 to 16 days, as shown in Figure 32. Once completed, the SS team shares the documentation and shipping information with the customer service team at the regional office, which then informs customers about the estimated time of arrival (ETA) and provides a detailed delivery note for the shipped items

In parallel, a seaway bill, essential for clearing the container at the port of arrival, is processed and sent via air courier. This document, critical for releasing the container from the port, typically takes 2-14 days to prepare and is often dispatched by air courier to ensure it arrives ahead of the shipment—sometimes up to two days before the container's arrival. Without the seaway bill, the container cannot be cleared from the port.

The sailing time from a Western European port (e.g., Port of Antwerp, Port of Rotterdam, Port of Le Havre, Port of Hamburg) to the regional market's port is generally 25-35 days. Customers typically experience a total waiting time of approximately two months from the time of order placement to the product's arrival at the destination port. Shipping times are largely beyond the company's direct control, as they depend on third-party logistics providers.

4.3 Scope and Limitations of the Work

This section describes the scope, assumptions, and limitations when collecting the current situation of the order-to-delivery process to focus the scope into a more manageable project. The scope will be limited to:

1. The numbers and graph do not represent actual data for confidentiality reasons.
2. The activities and stakeholders' names are anonymized and generalized for confidentiality reasons.
3. Confidential information is represented as a black box with "CONFIDENTIAL" text.
4. The analysis is limited to the business unit specializing in specialty coatings, specifically to a specialized disclosed product.
5. The process examined is only for the supply chain operations related to the targeted regional market.

6. The products analyzed will include those linked to sales orders with document dates between 1 January 2023 and 31 December 2023 and only products that have been successfully delivered.

4.4 Sub-Conclusion of Chapter 4

Chapter 4 provides an in-depth assessment of the current order-to-delivery process for the specialized product to the regional market. The chapter begins with data analysis and transformation to model quantitative data, segment customers by valuation, and determine current lead time distribution. It then presents process mapping, supported by interviews and brainstorming, to detail each activity in the order-to-delivery process. The scope and limitations of the data analysis and process mapping are outlined in the later part of the chapter.

The direct result of the data analysis is the focus on the sales made through the regional office as the primary data. The findings reveal an average lead time of 54 days for the total products of the scoped customer, which is more than the 31-day service level agreement. Make-to-order (MTO) items were prioritized due to the absence of safety triggers related to their characteristics. Notably, 67% of MTO items exceeded the service level agreement and will be further analyzed in Chapter 5.

The BPMN diagrams for sales order entry, sales order processing, and order fulfilment illustrate the process flow and touchpoints, highlighting inefficiencies and opportunities for improvement. The findings emphasize the need for better process alignment, enhanced interdepartmental coordination, and streamlined communication between key team functions. Limitations include data availability issues and excluding undelivered orders within the project scope.

This chapter establishes a foundation for the root cause analysis and recommendations for improvement. Chapter 5 will analyze these findings to identify the root causes and areas for enhancing the order-to-delivery process.

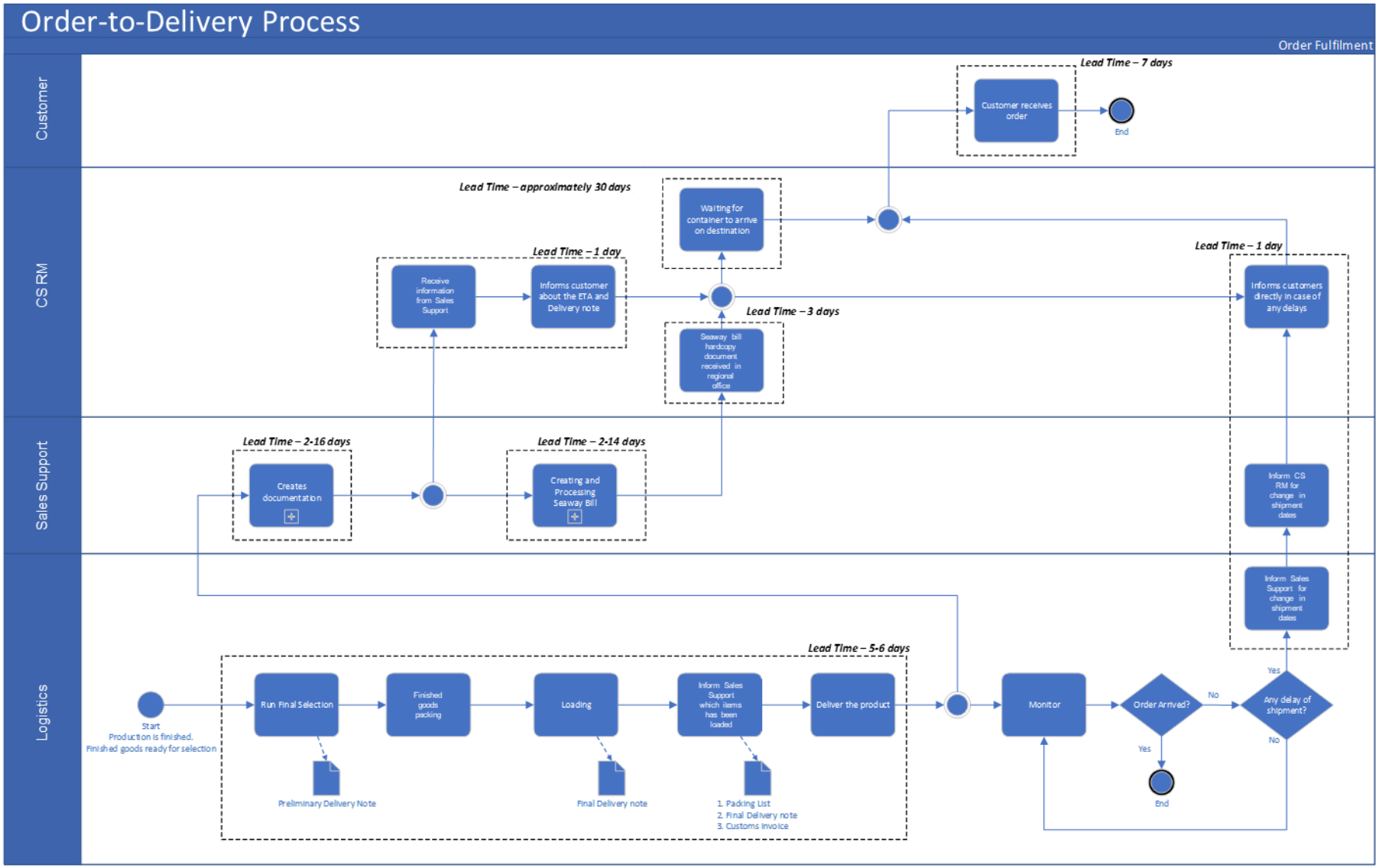

Figure 31 BPMN Diagram of the Order Fulfilment Process

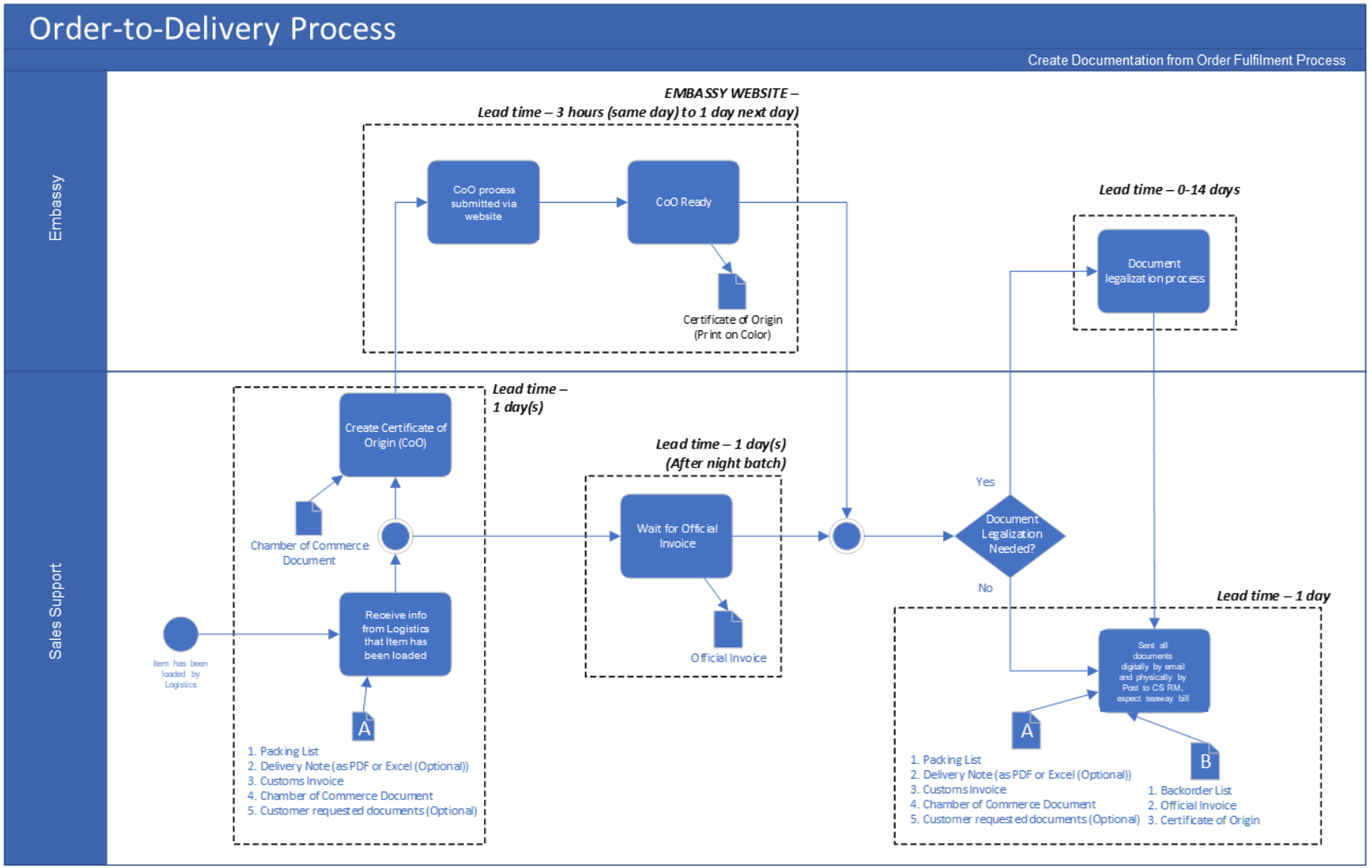

Figure 32 BPMN Diagram of the Create documentation-Order fulfilment Process

5 As-Is Analysis of the Current Situation Findings

Chapter 5 analyzes the findings from Chapter 4 using specific analysis methods explained in the background study. The chapter is organized into four (4) main sections: Section 5.1 examines the current lead time performance, starting with a Pareto analysis to identify areas with the highest potential impact (Section 5.1.1), followed by data analysis (lead time decomposition) and root cause analysis (5 Why analysis) to determine the underlying root cause (Section 5.1.2). Section 5.2 reviews the current process map and highlights improvements that can be made. Section 5.3 concludes and explains the key factors contributing to high lead times in the order-to-delivery process illustrated using a cause-and-effect diagram. Section 5.4 concludes the chapter by summarizing the root causes and potential improvement, which will be explored further in Chapter 6. Overall, this chapter provides a thorough analysis to understand the main issues and paves the way for proposing improvements.

5.1 Current Lead Time Assessment

5.1.1 Pareto Analysis

Building on the findings from Chapter 4, particularly Section 4.1.3, this section delves into which products should be analyzed further, using the Pareto analysis method and root cause analysis tools to identify the underlying causes of lead time issues observed in Section 4.1.3. Figure 33 illustrates a Pareto analysis chart based on lead time calculations (updated after confidentiality revisions). The Pareto analysis method follows the 80-20 principle, where 80% of the outcomes stem from 20% of the causes, referred to as the “vital few,” while the remainder is the “useful many.” In this case, nearly 80% of the total product quantity is impacted by fewer than 8% of the underperforming MTO items.

The analysis reveals that addressing these critical few items can yield substantial benefits with minimal effort. Specifically, 6 out of 76 products (approximately 8%) account for almost 80% of the total MTO items experiencing high lead times. Focusing beyond these top six items results in marginal improvements so that the focus will remain on these six products.

Figure 33 highlights the top items from the Pareto chart. The primary contributor to extended lead times is “Product 1”, accounting for more than 20%. The second and third highest contributors are “Product 2” and “Product 3”, contributing almost 20% and more than 15%, respectively. These three items represent more than 55% of problematic MTO items. The fourth item, “Product 4”, contributes approximately 10%, bringing the cumulative total to around 65%. The fifth item, “Product 5”, adds almost 10%, totaling 75%. Finally, “Product 6” contributes 4%, cumulating to almost 80% of the problematic MTO items.

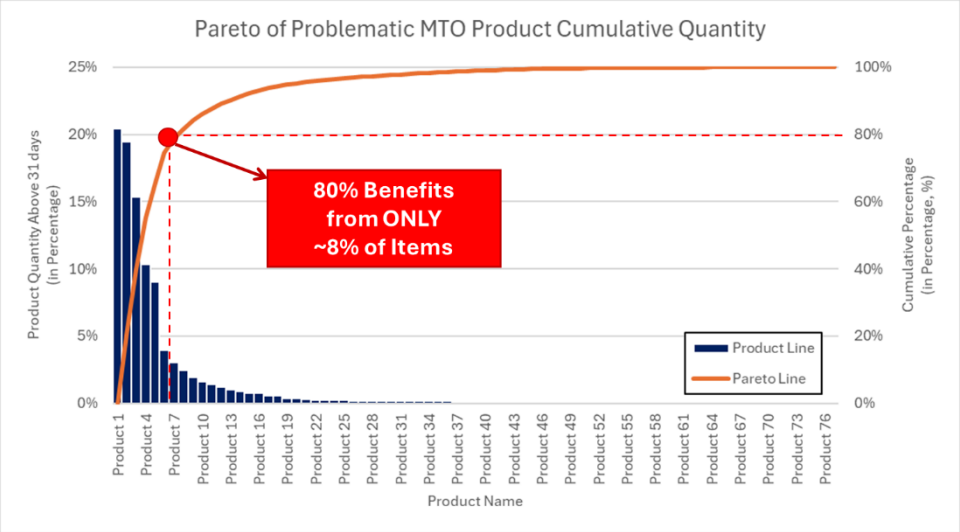

Figure 33 Pareto Chart from Lead Time Calculation Findings

From the findings in Section 4.1.3, this section explains in more detail the findings of which product to analyze further, including the Pareto analysis method and root cause analysis tools to find the root causes of the products analyzed.

5.1.2 Current Lead Time Analysis

To further understand the delays for the six products identified, based on the company's lead time definitions and service level agreements, a 5 Why analysis is conducted to determine the root causes of why these items were not ready on time.

5 Whys Analysis

To gain deeper insights, the analysis of Product 1 to Product 6 involves decomposing activities, detailed in Table 1 to Table 6. By combining sales order data and outbound delivery data, we can collect important dates such as order entry (order date), material availability, loading, and goods issue dates. This allows for calculating lead times for intermediate steps like production, packing, and loading. Your role in maintaining the accuracy and integrity of this data is crucial to our operations.

Table 1 until Table 6 reveal variations in lead time distribution, with production lead time being the most prominent contributor to delays. To address this, stakeholders relevant to the production process that is responsible for these products were consulted to determine the root causes of prolonged production lead times through a 5 Why analysis. The first question posed was:

1st Why: "*Why is the production lead time high and varies?*"

The response indicated that pinpointing the exact cause was difficult due to limited human memory and the absence of documented historical data. The stakeholder noted that while direct causes were hard to trace, potential reasons for high lead time were known. Factors affecting production lead time include:

1. Business Targets
2. Over- or under-production
3. Capacity allocation for semi-finished goods
4. Material master data settings for finished goods
5. Raw material procurement
6. Production capacity
7. Scheduling constraints
8. Technical disruptions

2nd Why: "*Why is there no historical data or documentation for orders, especially those exceeding the SLA?*".

The answer was that such data was not measured.

3rd Why: "*Why is this measurement not done?*"

The response was that it seemed as not urgent, so it was not included in regular operational tasks.

4th Why: "*Why is this documentation seen as not urgent?*"

The response was unclear, so the current root cause is "no urgency in improvement leads to no initiation of measurement", but other potential reasons included uncommunicated directives, overlooked messages, or an absence of strategic direction at the operational level.

Companies that prioritize continuous improvement understand that both internal and external factors can drive urgency. Maintaining a proactive, continuous improvement mindset is essential for staying competitive.

The company also uses KPIs such as weekly OTIF (On-Time, In-Full) reports that could help identify root causes of delays on a weekly basis. However, these reports do not include export items, making it impossible to apply this analysis to the regional market. Implementing this tool from other markets for the regional market could be beneficial.

For MTO items, which rely on short-term capacity, additional triggers or information for prioritization could help, though this depends on business strategies. While production deals with machine and manpower constraints, prioritizing MTO items might optimize capacity allocation.

To address the 4th Why, the measurements are needed in the smallest details or activity. Fostering a proactive, systematic approach focused on continuous improvement and customer-centric actions is necessary. Standardizing processes reduces variation and enhances performance consistency, allowing companies to identify areas for improvement and align efforts to better serve customer needs. Measurement on the defined activities in the process are important for bottlenecks resolution with a data-driven approach. Documentation of the critical issues and successful actions need to be recorded to have data for further improvement within the team's performance. This proactive approach helps mature process performance and supports ongoing enhancements. Implementing standardized metrics across business units and encouraging open communication ensures that sufficient data is available for corrective and improvement actions.

Table 1 Product 1 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 1 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	104	7.6%	03/01/2023	98	11/04/2023	6	17/04/2023	0	17/04/2023
Sales Order Line 2	7	4.6%	23/01/2023	3	26/01/2023	1	27/01/2023	3	30/01/2023
Sales Order Line 3	81	11.5%	26/01/2023	75	11/04/2023	6	17/04/2023	0	17/04/2023
Sales Order Line 4	59	0.4%	14/02/2023	128	22/06/2023	4	26/06/2023	-73	14/04/2023
	132	0.7%	14/02/2023	128	22/06/2023	4	26/06/2023	0	26/06/2023
Sales Order Line 5	145	1.7%	21/06/2023	139	07/11/2023	6	13/11/2023	0	13/11/2023
	107	4.2%	21/06/2023	139	07/11/2023	6	13/11/2023	-38	06/10/2023
	113	6.1%	21/06/2023	139	07/11/2023	6	13/11/2023	-32	12/10/2023
	138	6.1%	21/06/2023	139	07/11/2023	6	13/11/2023	-7	06/11/2023
	145	3.8%	21/06/2023	139	07/11/2023	6	13/11/2023	0	13/11/2023
Sales Order Line 6	98	6.1%	31/07/2023	99	07/11/2023	6	13/11/2023	-7	06/11/2023
	105	7.7%	31/07/2023	99	07/11/2023	6	13/11/2023	0	13/11/2023
Sales Order Line 7	7	9.2%	14/08/2023	3	17/08/2023	4	21/08/2023	0	21/08/2023
Sales Order Line 8	77	6.1%	21/08/2023	78	07/11/2023	6	13/11/2023	-7	06/11/2023
	84	7.7%	21/08/2023	78	07/11/2023	6	13/11/2023	0	13/11/2023
Sales Order Line 9	6	0.1%	24/08/2023	21	14/09/2023	-1	13/09/2023	-14	30/08/2023
	25	7.9%	24/08/2023	21	14/09/2023	-1	13/09/2023	5	18/09/2023
Sales Order Line 10	54	6.1%	13/09/2023	55	07/11/2023	6	13/11/2023	-7	06/11/2023
	61	2.5%	13/09/2023	55	07/11/2023	6	13/11/2023	0	13/11/2023

Table 2 Product 2 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 2 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	97	10.4%	23/03/2023	91	22/06/2023	6	28/06/2023	0	28/06/2023
Sales Order Line 2	31	14.9%	16/06/2023	25	11/07/2023	6	17/07/2023	3	17/07/2023
Sales Order Line 3	44	74.6%	10/10/2023	38	17/11/2023	6	23/11/2023	0	23/11/2023

Table 3 Product 3 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 3 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	25	7.5%	13/02/2023	21	06/03/2023	4	10/03/2023	0	10/03/2023
Sales Order Line 2	97	30.3%	23/03/2023	91	22/06/2023	6	28/06/2023	0	28/06/2023
	97	7.8%	23/03/2023	91	22/06/2023	6	28/06/2023	0	28/06/2023
Sales Order Line 3	31	45.7%	16/06/2023	25	11/07/2023	6	17/07/2023	0	17/07/2023
Sales Order Line 4	31	4.0%	04/08/2023	24	28/08/2023	4	01/09/2023	3	04/09/2023
Sales Order Line 5	40	0.7%	14/09/2023	34	18/10/2023	6	24/10/2023	0	24/10/2023
Sales Order Line 6	46	4.0%	07/12/2023	40	16/01/2024	6	22/01/2024	0	22/01/2024

Table 4 Product 4 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 4 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	73	25.3%	07/02/2023	69	17/04/2023	4	21/04/2023	0	21/04/2023
	73	24.7%	07/02/2023	69	17/04/2023	4	21/04/2023	0	21/04/2023
Sales Order Line 2	64	4.5%	26/07/2023	58	22/09/2023	-15	07/09/2023	21	28/09/2023
	64	20.5%	26/07/2023	58	22/09/2023	-15	07/09/2023	21	28/09/2023
Sales Order Line 3	29	25.0%	25/10/2023	23	17/11/2023	6	23/11/2023	0	23/11/2023

Table 5 Product 5 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 5 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	36	2.5%	23/01/2023	30	22/02/2023	6	28/02/2023	0	28/02/2023
Sales Order Line 2	51	26.1%	07/02/2023	45	24/03/2023	6	30/03/2023	0	30/03/2023
	51	14.3%	07/02/2023	45	24/03/2023	6	30/03/2023	0	30/03/2023
Sales Order Line 3	100	2.5%	13/02/2023	92	16/05/2023	8	24/05/2023	0	24/05/2023
Sales Order Line 4	28	5.1%	24/03/2023	24	17/04/2023	4	21/04/2023	0	21/04/2023
Sales Order Line 5	28	44.1%	31/05/2023	41	11/07/2023	6	17/07/2023	-19	28/06/2023
	47	0.3%	31/05/2023	41	11/07/2023	6	17/07/2023	0	17/07/2023
Sales Order Line 6	46	5.1%	07/12/2023	40	16/01/2024	6	22/01/2024	0	22/01/2024

Table 6 Product 6 Lead Time Decomposition and Calculation

Sales Order Line	Order-to-Delivery Lead Time (in Days)	Quantity Percentage relative to Product 6 (in Percentage)	Order Date	Production Lead Time (in Days)	Material Availability Date	Packing Lead Time (in Days)	Loading Date	Loading Lead Time (in Days)	Goods Issue Date
Sales Order Line 1	78	5.3%	21/06/2023	72	01/09/2023	6	07/09/2023	0	07/09/2023
	78	9.8%	21/06/2023	72	01/09/2023	6	07/09/2023	0	07/09/2023
Sales Order Line 2	38	41.3%	31/07/2023	66	05/10/2023	6	11/10/2023	-34	07/09/2023
	72	23.1%	31/07/2023	66	05/10/2023	6	11/10/2023	0	11/10/2023
Sales Order Line 3	51	20.5%	21/08/2023	45	05/10/2023	6	11/10/2023	0	11/10/2023

5.2 Current Process Map Assessment

This section evaluates the process map detailed in Section 4.2. A brainstorming approach is used to analyze the connections between process mappings. Insights from the company's operating model (Figure 27) and the Value-Added Chain Diagram (VACD) for order-to-delivery process (Figure 28) indicate that processes are highly interconnected across functions, relying on quality inputs to produce effective outputs. Each process must adhere to defined standards in this interconnected system, as one process's output often serves as the input for another. Thus, maintaining high-quality inputs, processes, and outputs is essential. The order-to-delivery process is divided into three main stages: sales order entry, sales order processing, and order fulfilment.

Sales Order Entry

The sales order entry process (illustrated in Figure 29) begins with the regional office inputting orders into its inventory management system. However, due to differing systems used across regions, orders must be exported into an external document (e.g., a spreadsheet) and sent to the central production facility, where a dedicated team re-enters them into the local system. This duplication introduces inefficiencies and delays. Integrating the systems and improving coordination between teams across regions could streamline this process and enhance efficiency.

To improve the process, it is proposed to divide the sales support function into regional teams, such as one managing orders for the production facility and another for the regional office. Both teams would operate within a unified system, allowing stakeholders to access and monitor orders in real-time. This integration would ensure up-to-date information on product availability and reduce delays by eliminating unnecessary intermediaries. Establishing clear workflows for updating product status, along with well-defined roles and responsibilities, should be documented in a standardized operations manual.

Regular coordination between regional teams, proactive discussions to align orders, and timely communication about product updates would further streamline operations. Consistent documentation and adherence to agreed timelines would support process efficiency and reduce errors.

Key improvements include system integration across regions, coordinated discussions to align decisions and actions, and the creation of standardized procedures for updating product status and availability. Clear and transparent documentation of workflows and roles is essential to facilitate these improvements and ensure long-term operational efficiency.

Sales Order Processing

Once an order is entered into the system (Figure 30), it triggers activities in production. Accurate data entry at this stage is critical for effective downstream decision-making. Coordination between support teams and logistics is required for container and shipping arrangements. Shipment details are communicated via email, and ensuring the accuracy of this information is crucial to avoid delays or the need for rescheduling.

Smaller shipments may be delayed to optimize container utilization, potentially impacting delivery timelines. Support teams must carefully plan and coordinate to ensure timely delivery while maintaining customer satisfaction. Larger shipments may necessitate additional containers, requiring coordination with logistics teams due to lead times associated with third-party providers. This challenge is further amplified by global container shortages, emphasizing the importance of precise planning and accurate data to enable efficient decision-making.

Challenges posed by third-party logistics providers, such as container availability and scheduling, can lead to increased lead times due to uncertainties. Addressing these risks requires meticulous planning, effective coordination, and strong partnerships with logistics providers to secure the necessary transport and maintain smooth operations.

Order Fulfilment

The order fulfillment process (depicted in Figure 31) begins when goods are available at the logistics warehouse, marked by the "Material Availability Date." Lead time analysis (refer to Section 5.1.2) indicates that logistics handling consistently meets the one-week service level agreement (SLA). To maintain efficiency, periodic assessments of warehouse processes could be beneficial.

Once shipments are dispatched and en route to their destination, the sales support team is responsible for preparing documentation, involving coordination with multiple stakeholders (Figure 32). This step is heavily influenced by external regulations, such as customs procedures dictated by government bodies. Ensuring the accuracy of initial information minimizes the risk of resubmissions. Establishing strong working relationships with regulatory institutions can streamline workflows by promoting mutual understanding of the required procedures. Proactive follow-ups on document status can help resolve issues early and expedite the overall process.

Timely relay of these documents to the regional office is essential to facilitate customs clearance and local administrative tasks. Accurate and prompt information enables the regional office to prepare and keep customers informed about order status, fostering trust and accountability. Once documentation is complete and shipments are in transit, stakeholders must actively monitor progress, addressing delays as they arise. While transit times are largely controlled by third-party logistics providers, proactive coordination and follow-ups by the company are critical. The regional office should plan for customs clearance and the distribution of goods from the local warehouse to end customers, such as distributors.

Effective communication among stakeholders is crucial. Regular updates ensure all parties are aware of shipment status, potential delays, cancellations, or issues. Implementing an integrated platform where stakeholders can update information, monitor lead times, and track process delays could enhance efficiency. This platform should align with existing workflows while enabling proactive, customer-focused actions. In cases of shipping delays, the logistics team should promptly inform the support team, which in turn updates the regional office to ensure timely communication with customers. Reducing intermediaries in this communication chain could improve response times and streamline information flow.

To enhance order fulfillment, the focus should be on robust stakeholder management, clear communication, and exploring innovations for streamlining documentation and information

flow—particularly for critical processes such as customs declarations. While international regulatory frameworks may present challenges, fostering relationships and maintaining consistent communication are key to improving operational efficiency.

Overall

1. **Improvement Insights from Process Mapping**

   Analyzing the process map reveals potential improvements, such as implementing a visual tracker for the order journey based on a standardized process map and ensuring comprehensive documentation of roles and responsibilities at all levels across departments. A well-programmed backend platform is necessary for analyzing SLAs, technical workflows, bottlenecks, technology adoption, and root cause identification. This platform should be user-friendly and integrated with current processes to facilitate data-driven improvements. Establishing a visible process activity timeline for coordination across all regions would enhance transparency and engagement.

   Measuring the time for each process step is critical for evaluating efficiency. Stakeholder coordination is essential, even if using one integrated tool is challenging. At minimum, a platform should consolidate agreed information as a basis for future improvements. Without accurate data, assessing current performance and identifying areas for enhancement becomes difficult. All activities should include clear work instructions to facilitate time measurement, review, and necessary evaluations for continuous improvement.

   The process outputs are only as good as the quality of inputs and workflows. By linking the process map to a cause-and-effect analysis, relationships between activities and their outcomes can be better understood. However, detailed metrics and data collection are limited due to inconsistent KPI measurements and insufficient alignment among stakeholders. A comprehensive internal process map would help identify activities, processes, and associated KPIs, ensuring more accurate data collection and consistent performance measurement. Effective inputs and processes produce quality outputs, creating a cycle of continuous improvement. It is crucial to have a clear path from the start, which can then be refined and detailed for better results.

2. **People as a Key Element**

   The success of process improvements relies on having the right personnel. Just as system requirements guide developers, specific traits and capabilities should guide team selection. A continuous improvement mindset is essential. With the right team and supportive environment, aligning actions with the overarching goals of the supply chain becomes more manageable. Clear visions and directives from management are vital for ensuring that teams work cohesively toward process optimization.

3. **3P Framework and Organizational Behavior**

   Lead time reflects the interactions within the entire order-to-delivery process as the result or overall performance of the process. A well-optimized process results in superior lead time performance, which requires a capable and aligned team. Systematic thinking begins with people, who are essential for understanding and influencing workflows. Figure 34 illustrates

the 3P framework in a concentric circle, showing how performance, processes, and organizational behavior interconnect. While real-life processes are complex, this case study focuses on lead time as the performance variable, the order-to-delivery process as the process variable, and organizational behavior as the people variable.

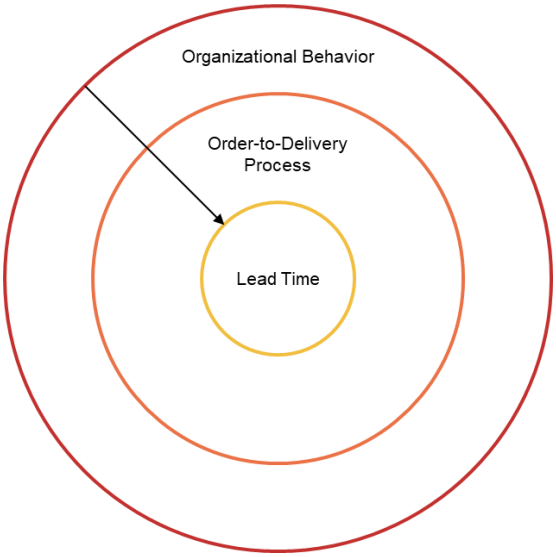

Figure 34 Relation of 3P Framework on the Case Study in Concentric Circle Visualization

5.3 Key Factors in the Order-to-Delivery Process

Based on the process mapping and lead time assessments, a cause-and-effect diagram is constructed to identify potential factors contributing to high lead times. Stakeholder interviews are conducted to gather insights into the causes reflected in the process map, and the results of the interviews are coded to obtain the possible causes of the high lead time and how they relate to the main categories in the cause-and-effect diagram. This section summarizes the key factors identified and organizes them within the cause-and-effect diagram. The goal is to pinpoint the factors impacting lead time from the perspective of stakeholders directly involved in the process.

During the interviews, individuals associated with specific roles in the swim lane diagram were asked to verify the activity flow and share their department's perspective on the overall process. This includes evaluating their performance, constraints, capabilities, and reasoning regarding lead time delays. The semi-structured interviews provided detailed information, then coded and grouped into categories. These findings were incorporated into the cause-and-effect diagram, grouping related causes into broader categories. This approach enriches the diagram, offering a clear overview of the root causes of the problem.

The interviews, rooted in the process map from Section 4.2, ensured data was collected from individuals directly interacting with the problem, enhancing the reliability and relevance of the findings. The methodology for the cause-and-effect diagram aligns with the 6M framework (manpower, method, measurement, machine, mother nature, materials), as outlined in the literature review in Section 3.4. This framework was chosen because it is consistent with the company’s continuous improvement practices, making it familiar and practical for employees.

The interviews, analyzed using the 6M framework, identified several possible causes across the six (6) categories shown in Figure 35, which includes:

1. **Manpower**: The causes include human factors, mindset and culture, and communication and collaboration challenges.
2. **Method:** The causes include process issues, and documentation & standard operating procedures (SOPs)
3. **Measurement**: The causes include data & metrics, and KPI management.
4. **Machine:** The causes include forecasting & planning, and system & technology.
5. **Mother Nature:** The causes include global supply chain conditions and logistics challenges.
6. **Materials**: The causes include the material or product characteristics, and the issues related to the inventory management of the materials and product.

These findings form the foundation for understanding the root causes of extended lead times. Each category and its related causes will be discussed in more detail in the following subsections, providing deeper insights into their impact on lead time and potential solutions.

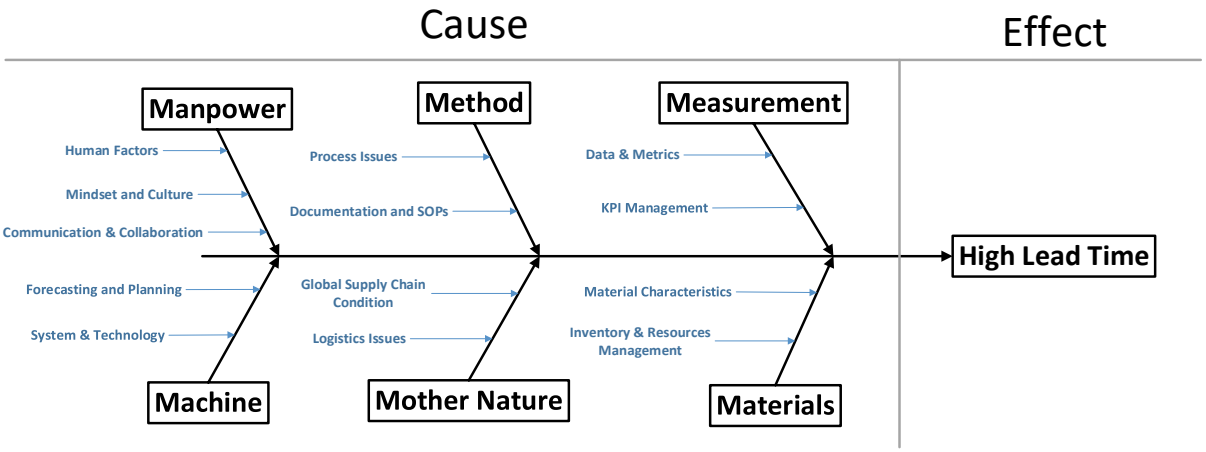

Figure 35 Cause-and-Effect Diagram of the Current Situation

5.3.1 Manpower

The first primary category of the fishbone diagram, manpower, refers to the individuals or groups involved in the process. It focuses on how human actions, behaviors, and performance can influence the lead time of the process. The secondary category in this section is divided into three (3) sub-categories: human factors, mindset and culture, and communication and collaboration. The findings of each sub-category are discussed in the following sections.

5.3.1.1 Human Factors

Human factors are direct human interactions that impact operational efficiency and process effectiveness. One key element is human error, which can manifest through incorrect data entry or procedural mistakes. These errors lead to rework, resulting in delays and extending lead times. Additionally, errors can negatively affect both internal operations and customer satisfaction. For instance, an error in inputting container details may lead to incorrect container bookings, thereby disrupting the process flow and increasing the overall workload. Mitigating human error requires robust automation and standard operating procedures, reducing manual intervention and minimizing potential mistakes.

Other factors affecting lead time are incomplete handovers or onboarding training programs. When personnel transitions occur without thorough handovers or adequate training, the new

personnel may lack the necessary knowledge to perform their roles effectively. Without the proper and complete knowledge to execute the task, personnel would require a longer adjustment period and learning duration, as well as extra support from other team members, which increases the workload of the team members, which creates more workload and increases lead times. Personnel may also be unaware of critical information, processes, or routines when doing the tasks.

Following the handover factor, the ability and knowledge to use and develop tools and resources are seen to be an important factor. Tools and resources are there to help employees to improve their work performance. However, the inability to utilize the available tools and resources can lead to unoptimized results. This affects the productivity of the workforce and the utilization of the tools and resources themselves. For example, the lack of knowledge about key tools such as SAP or Excel results in underutilization, increases delays, reduces operational efficiency, and impacts the overall lead time and overall satisfaction level of the process.

Disparities in skill levels across teams create bottlenecks, as tasks can be unevenly distributed in quantity and quality, and certain personnel may experience more workload than others. The imbalance can put at risk the team and company's ability to adapt to changes in the environment and implement improvements, leading to inhibition of improvement implementation in processes or workflows.

Lastly, ambiguity in task objectives and targets creates confusion, inefficiency, or misaligned results. When tasks or end goals lack clarity and focus, personnel may not fully understand the priorities and essence of the mission, resulting in misdirection of efforts and outcomes that fail to meet expectations. This can be particularly problematic in projects or tasks outside routine operations, where clear guidance is critical.

5.3.1.2 Mindset and Culture

Mindset and culture shape how individuals and departments respond to challenges and adapt to organizational changes. A critical observation is the need for a continuous improvement mindset. Encouraging continuous improvement fosters a culture where employees consistently seek ways to enhance processes and outcomes. Without this mindset, suboptimal practices become the norm, potentially stifling innovation and preventing the company from achieving its full potential.

Moreover, a lack of customer-centric focus can adversely affect the company's performance (Kotler & Keller, 2016). Prioritizing internal processes over customer needs places unnecessary strain on clients, who must adjust to the company's limitations rather than being served efficiently. A shift toward proactive customer engagement, where the company anticipates and addresses customer demands, can significantly enhance satisfaction and loyalty.

Another issue is the prevalent focus on firefighting rather than long-term continuous improvement. While reactive problem-solving is sometimes necessary, consistently addressing only immediate issues without investigating root causes limits the organization's ability to implement sustainable improvements. By focusing on root cause analysis and long-term solutions, the organization can reduce the frequency of firefighting and improve overall efficiency.

5.3.1.3 Communication and Collaboration

Effective communication and collaboration are crucial for aligning the stakeholder's efforts and ensuring efficient workflows. The need for harmonization between stakeholders is essential. Misalignment between stakeholders can result in delays, rework, and inconsistencies in fulfilling customer needs. Stakeholders that operate in silos may prioritize their objectives without considering the broader organizational goals, leading to inefficient processes.

A clear definition of roles and responsibilities across stakeholders is essential for swift issue resolution. When roles are not clearly assigned, ownership of tasks and problems becomes ambiguous, causing delays and confusion. Establishing clear responsibilities ensures that tasks are handled by the appropriate individuals, enabling more effective collaboration and faster problem-solving.

Finally, communication extends from the organization's internal environment, and timely communication with customers is paramount to maintaining trust and reliability. Proactively informing customers about the status of their orders, potential delays, or incomplete shipments allows them to plan accordingly. Delayed communication, such as informing customers of incomplete deliveries after shipments are en route, can damage customer confidence and disrupt their operations. Ensuring timely and transparent communication strengthens customer relationships and reinforces the organization’s reliability.

5.3.2 Method

The second primary category of the fishbone diagram, method, refers to the processes, procedures, and standards that govern the company's operations. The method category is divided into two (2) secondary causes: process issues and documentation and standard operating procedures (SOPs). The findings of each sub-category are discussed in the following sections.

5.3.2.1 Process Issues

Process issues are significant factors that impede the efficiency and effectiveness of operation and troubleshooting, leading to delays, inconsistencies, and unresolved problems. These issues can arise from the lack of defined streamlined workflows, inadequate tracking and measurement systems, and unclear responsibilities.

A critical issue affecting lead times is the slow adaptability to change. This could stem from outdated procedures or the size of the organization, which make it difficult to respond swiftly to market demand or internal manufacturing challenges. The inability to shift and adjust in response to changes may lead to a loss in competition and increase lead times as more time is needed to respond to the customer.

Work is limitedly integrated across stakeholders, leading to partial alignment operations. Stakeholders work independently with limited coordination with adjacent departments, resulting in misaligned goals and inefficiency in communication and decision-making. This siloed approach makes collaboration difficult and prevents the organization from optimizing its end-to-end processes.

Personnel often possess deep knowledge of certain processes but lack an understanding of the complete operational workflow. This limited knowledge hinders cross-functional collaboration and creates barriers to identifying inefficiencies or opportunities for process improvement, especially when cross-checking between adjacent stakeholders.

The absence of a defined, mapped, and communicated end-to-end process is a significant game changer. By clearly understanding how different stakeholders interconnect, link, and influence each other either by their inputs, outputs, measured variables, and process, areas for improvement can be visually known by all stakeholders to be pinpoint and focused for development. Many of the processes now are tacit knowledge. By knowing the process map, the company can better identify the bottlenecks, the source of each stakeholder's inputs, and the destination of each stakeholder's output, therefore collaborating and integrating information with each other. A comprehensive end-to-end process mapping would allow for better integration, increased accountability, information robustness, and a strong foundation for continuous improvement efforts.

Delays that lead to increased lead time may come from manufacturing delays that can result from various other factors, including machine breakdown, raw materials shortages, or inefficient processes. However, the important thing here is to have a well-defined and robust contingency planning process or mechanism. Hence, the stakeholders already know what needs to be done to mitigate and minimize the unwanted effects of these problems on the workflow.

A heavy reliance on manual processes, such as updating and reporting, through handmade spreadsheet tools and emails. This may introduce inefficiencies and increase the risk of human error. Automated planning systems would reduce the human error factor and speed up the process by eliminating manual steps. Integration in the company would create "one truth" information that can be used as reliable and updated information to improve or resolve issues within the company.

There is a need for a more customer-focused order assurance flow and order tracking system that provides both the customers and the company with real-time and updated better visibility into the order status, including what products are being shipped and delivery information. Currently, the order assurance process lacks transparency and real-time updates, which may lead to frustration and uncertainty for the customer, as they may be unaware of critical details until it is too late. Internally, the company also face challenges due to the limited visibility into the order and manufacturing status, which may slow down the ability to manage and adjust schedules and orders efficiently. Implementing a transparent and integrated order assurance and order tracking system may allow both the customers and the company to track orders in real-time and increase customer journey experience and satisfaction level. The company can significantly enhance the order fulfilment reliability, customer satisfaction, and overall process efficiency as these data are processed and visible to the stakeholders.

The company also require better visibility into future market demands and customer orders. This market visibility in the process is important for accurate forecasting and planning, which in turn minimizes lead time, improves resource allocation, and optimizes capacity. By having a robust model, complete data, and optimum system, visibility may reach its potential of helping the company to give more efficient and effective performance.

Lastly, unclear responsibility within or between the stakeholders can lead to unresolved issues, delays, and other negative effects. Confusion about who to refer to or who should take action is part of the negative effect when task ownership is not clearly defined. Clearly defining roles and responsibilities is essential to ensure accountability and streamline problem-solving.

5.3.2.2 Documentation and Standard Operating Procedures (SOPs)

The absence of comprehensive, easily understandable, and standardized documentation of process procedures presents challenges to the consistency, quality control, and process improvement efforts in the company. This section highlights the findings regarding documentation and standard operation procedures (SOPs) that impact the lead time.

From observation and interviews, it is seen that several operational processes are not well-documented. Without formal and standardized documentation, such as updated process maps and work instructions, it is challenging to assess current practices and identify areas for optimization. This also relates to the tacit knowledge of each personnel that does the operational task. Moreover, backing-up, conducting handover, doing training and onboarding might be a challenge, especially when the tasks are a repetition. Having a documented standard way of working provides consistency and quality, especially for new personnel or when implementing change, which would give the same understanding of how the process works.

Regular and scheduled review and updates of SOPs are critical to ensuring that procedures remain relevant. In the absence of a formal review schedule, SOPs may become outdated, leading to irrelevant procedures being followed, especially when the other systems or procedures in the process change. Therefore, implementing a regular review schedule would ensure that the procedures evolve with the company's needs and goals.

In a more specific case, it is found that the service level agreements (SLAs) are based on informal rules or experience in the process, without formal documentation or metrics definitions of the SLAs. This lack of a written, measured, and well-defined SLA creates ambiguity regarding service expectations and delivery timelines, thus relying on experience rather than data-driven metrics. It also inhibits further process improvement as different stakeholders may have different assumptions, understanding, and definitions regarding the content of the rules. Formalizing the SLAs, defining the content with clearly defined parameters, and gaining compromised decisions from all stakeholder's capabilities would provide a clear benchmark for performance, accountability, and desired expectation levels. Having concrete measured metrics criteria and execution can help to evaluate the SLAs if the execution has met the criteria of the agreement and how the SLA can be improved for better service levels and process efficiency in the overall company's performance.

Different offices, plants, or distribution centers within the organization are observed to follow varying SOPs, leading to inconsistencies in how processes are executed. This inconsistency makes it difficult to maintain a uniform standard of quality and efficiency across the entire operation. Harmonizing the SOPs across all plants is essential for establishing a unified operational approach. This requires the agreement of different plants/offices/sites in the region or globally to discuss and agree upon a certain standardized way of working.

5.3.3 Measurement

The third primary category of the fishbone diagram, measurement, refers to the measured quantitative and qualitative data, metrics, and KPIs and provides the foundation for data-driven decision-making, process optimization, and performance tracking. The measurement category is divided into two (2) secondary causes: data and metrics and KPI management. The findings of each sub-category are discussed in the following sections.

5.3.3.1 Data and Metrics

The ability to measure, gather, analyze, and act to accurate data and metrics is crucial for understanding the performance of a process and to ensure and optimize its efficiency. In the current context, several issues in data and metrics have been collected and identified that are potentially affecting the organization's ability to utilize data for improving the current lead time and decision-making in other areas in the company.

In many cases, only a set of metrics is monitored, which limits the company's understanding of its overall performance. This may be due to a lack of clarity about which variables should be measured across the company. To address this, it is important to conduct a comprehensive review of all company or specific team needs and integrate them into a unified measurement system. Findings are shown in Section 5.1.2 that some variables' measurements in the set KPI are not available. For our example, defining the exact points at which lead time should be measured throughout the decomposition of the activities in an order-to-delivery process is not possible because there are missing measurements and also undefined process mapping. With this condition, the KPI cannot be calculated as comprehensively as the theory, and therefore, it is not possible to analyze it fully.

Another example of data and metrics is OTIF (on-time and in-full). OTIF data for the regional market is not available. There is also no record of the historical data, which may be caused by missed data storage. With this, the OTIF KPI for this market is not available. Therefore, process efficiency is unknown, and improvement cannot be made with this approach. The lack of integration between the company's system and the definition of the integrated supply chain will need to be emphasized further as the scope of the supply chain. One standard way of working and an integrated supply chain system are important.

A fundamental issue is that some (but not all) key performance indicators (KPIs) are not consistently and uniformly measured. Without tracking KPIs, the company will be limited in evaluating its performance against objectives or identifying areas for improvement. This lack of measurement hinders the ability to implement effective performance management strategies.

Lastly, data and metrics will relate to other factors in this section's findings. In Section 5.3.6, MRP setup and forecast causes are also the result of inaccurate data and metrics recorded or measured. Therefore, the method of collecting the data and what data is collected will play a significant role as the quality of input to the system will be the one that is processed. Hence, this relates to the rightness of input in the system. Having the same process but the wrong input will result in the wrong output or incorrect decision.

Without precise performance metrics or benchmarking, the efficiency of current processes remains in question. This lack of visibility prevents the company, specifically for teams from

assessing which areas require improvement and focus. Also, this inhibits the ability to make data-driven decisions to enhance operations

5.3.3.2 KPI Management

Key performance indicators (KPI) management involves identifying the right indicators and ensuring that KPIs are regularly measured, monitored, evaluated, and used to guide decision-making. The findings show that sometimes, KPIs are not used as a decision-making consideration due to the inability to reflect the real-life situation of the problem. The following issues have been identified regarding managing KPIs within the company.

The absence of comprehensive KPI measurement across the company is a significant challenge. Without robust and complete KPIs, measuring progress toward strategic goals or assessing the effectiveness of process improvements is difficult. Establishing a system that tracks and measures all relevant KPIs will for better performance management and continuous improvement.

Establishing the correct performance indicators that reflect the company's commitment to its goals, priorities, and customers. These indicators should be developed and agreed upon by all stakeholders and must be regularly reviewed to ensure the indicators stay relevant and effective. By aligning KPIs across departments and functions, the company can create an aligned performance management system that drives consistent improvements and unified synchronization within the stakeholders. Without this, different stakeholders may work toward conflicting objectives, further complicating efforts to drive improvements. Some performance indicators in other regions, such as backorders, out-of-stock, stock availability, OTIF, etc., have been collaborated well. However, these actions would need to be extended to other regions as well to ensure the same quality of work throughout the region.

Lead time can be added as a performance indicator that is important relative to the customer, as discussed in Section 3.1.2, that time is a strategic indicator and absolute regardless of which perspective it is looked from. By knowing the running lead time, stakeholders can know whether the orders have been met or not and could proactively work on delivering and paying more attention to potential delaying orders,

The regional office emphasized that reliability is a more important performance than lead time. This highlights a disconnect between what is measured and what matters more to stakeholders. KPIs should reflect the priorities of both internal and external stakeholders. Data and signaling systems should be readily available to inform decisions. Without this alignment, the organization risks focusing on the wrong metrics, leading to inaccurate strategy decision-making that can lead to suboptimal outcomes. For example, reliability can be measured by OTIF by having the product delivered on time and completely, which reflects the company's ability to deliver reliably. Lead time is also a part of the OTIF where it measures the on-time component of how much time the company needs to complete the process (e.g., order-to-delivery process).

Currently, data and metrics are not granular enough to detect problems at the product level before they escalate. As a result, product issues are only discovered when they have already caused disruptions. This reactive approach limits the company's ability to manage inventory effectively. Shifting towards preventive measures, where potential product issues are identified and addressed before they cause major or minor disruptions, will improve operational

performance. Preventive efforts are much more manageable compared to reactive curative actions.

5.3.4 Machine

The fourth primary category of the fishbone diagram, machine, refers to the tools, systems, and technologies used within an organization. The machine category is divided into two (2) secondary causes: forecasting and planning, and systems and technology. The findings of each sub-category are discussed in the following sections.

5.3.4.1 Forecasting and Planning

Accurate forecasts and effective planning are essential for ensuring resources align with the market demand and the production side. Forecasting and planning are part of the system or the virtual machine used as a tool for the company to plan and produce the correct quantity of products to cope with the customer's demand.

Fluctuating demand is a significant challenge in planning that arises from the unpredictable nature of monthly demand from the market. Annual demand may remain constant, but when zoomed into a monthly basis, unstable demand and monthly variations make it challenging to forecast, disrupting production, replenishment, and inventory management. This irregularity makes it challenging to optimize inventory levels, as having excess stock may increase cost (storage, loss due to product shelf-life expiration, etc.), while too little stock results in lost sales or high lead time due to reactive production. To address this, the company may need to develop flexible and agile planning strategies that account for demand fluctuations, perhaps by incorporating agile and responsive production and inventory strategies.

Market characteristics and nature may also present complex challenges when forecasting demand. Tools such as market segmentation and customer archetypes may help to display customer purchasing behavior. However, demand trends are still challenging to predict, but a visual map of where the market stands hints at how the company needs to deal with the market. Coping with such market characteristics requires a forecasting model considering this type of market volatility. Also, a robust market analyzing system can help calculate and predict changes in trends more effectively, so the company may anticipate such fluctuations to adjust and adapt its internal capabilities in delivering the right satisfactory level of services.

Limited visibility of the market is also a factor that induces poor forecasting. Several factors underlying this can include insufficient outreach by customer services, irregular market patterns, lack of reliable regional data, and other factors. Improving market visibility is essential to better forecasting and aligning production with market needs. Improving market visibility is essential as it is one of the leading factors in better forecasting for better alignment with production to meet actual market demand. The company could explore strategies for better forecasting, such as enhancing customer relationships and service, conducting market research, or developing a robust forecasting model. Therefore, the company may receive good input and processes to get good output. This is done to gather more reliable and precise market data.

5.3.4.2 System and Technology

Technological infrastructure and systems play vital roles in providing the company's personnel with adequate tools to deal with daily reporting, data analysis, forecasting, and other operational

activities. However, disparities in systems and a reliance on manual processes present obstacles that affect the company's ability to operate tactically across regions.

One of the factors that may impact lead time is the heavy reliance on spreadsheets. Updating and analyzing data with a spreadsheet may be accessible as a standard tool used even from an early study age. Despite being flexible, it can be challenging when the spreadsheet is used for managing large-scale operations requiring real-time data processing and analysis. The many stakeholders involved in manual data entry and analysis may increase the risk of human errors and the time needed to complete all the required actions for the reporting. Implementing a more sophisticated, robust, and automated data management system could streamline data analysis, reduce human errors, and improve decision-making references. Additionally, transitioning to integrated planning and forecasting tools would allow for more accurate and efficient data handling.

Another key challenge regarding the system is using different planning tools between the offices in the same region. The regional market uses System B, whereas the production facility in Europe uses System A. The different systems may create inefficiencies in data storing, updating, reporting, and analysis. The system architecture and usage must also be integrated to standardize processes across the regions. The lack of integration between these systems can delay data sharing, forecasting errors, and inefficiency in aligning operations between the two (2) regions. To mitigate these issues, the company should consider integrating these systems or adopting a single standardized platform that enables smoother cross-regional operations and data synchronization.

Lastly, implemented tools in the organization can be utilized to integrate with the other tools in the supply chain process map. In the meantime, tools such as PowerBI, SAP, and Excel can be utilized by defining the proper process to smoothen the current process. However, long-term plans and utilization need to be considered, as a constantly changing way of working would be difficult, as personnel would need to adjust and adapt too often, making the team always on the left-hand side of the learning curve.

5.3.5 Mother Nature

The fifth primary category of the fishbone diagram, mother nature, refers to external environmental or third-party factors that are outside of the company's control and impact business operations. The mother nature category is divided into two (2) secondary causes: global supply chain conditions and logistics issues. The findings of each sub-category are discussed in the following sections.

5.3.5.1 Global Supply Chain Condition

The global supply chain is highly interconnected, and disruptions in any part of the chain can lead to impacts on the overall supply chain. Effects such as increases in cost and lead times are the most visible impact on companies and customers. Geopolitical tensions may pose a threat to the stability of the global supply chains. This affects both costs and lead time. Companies must remain agile in responding to this external pressure to explore alternatives to mitigate the risks of geopolitical instability.

5.3.5.2 Logistics Issues

Logistics plays a huge role in maintaining efficiency and lead time in the supply chain. This includes container availability, vessel reliability, and shipping selection. Issues in this area are critically impacting the lead times, especially logistics, which are factors that are outside of the company's control due to its third-party nature.

Container availability is one of the most challenging issues as it impacts the paints and coatings industry and the whole global supply chain. A shortage of containers can significantly delay shipments. When containers are unavailable, shipments can be delayed or canceled, causing a ripple effect on the supply chain. As in the regional market, shipments are usually delivered by sea and for urgent requests by air; because sea freight is the primary logistics vehicle, container issues will directly impact the supply chain. This poses a risk to OTIF and backorder performance indicators, where products could not have been delivered in full, and delays would cause the order not to be on time. The delay will create undelivered products in the schedule, increasing backorders. This effect directly impacts customer satisfaction and relationships with customers. Often, from the perspective of the shipping line, large customers may prioritize container allocation and allocate the slot to the large companies, rolling the smaller companies into the following shipment schedule, which delays shipping even further. The condition of container availability requires companies to develop more flexible logistics strategies to ensure the timely delivery of their shipments. Further research to address container shortages is much needed for better logistics strategies and performance globally.

Vessel issues can also affect logistics and the overall lead time. If a container talks about space in the vessel, vessel issues talk about the vehicles and their management, particularly the routes taken and port conditions. Vessel operations are managed by external logistics partners, and companies have little to no control over these delays. Delays may occur due to vessel breakdowns, changes in shipping routes due to weather or geopolitical reasons, or slot availability in the ports. Maintaining close communication with logistics partners and having alternative plans are ways to minimize the impact of delays in the supply chain.

5.3.6 Materials

The sixth primary category of the fishbone diagram, materials, refers to the physical management of the product or components required to fulfill orders and meet customer demand. The materials category is divided into two (2) secondary causes: materials characteristics and requirements and inventory and resource management. The findings of each sub-category are discussed in the following sections.

5.3.6.1 Materials Characteristics and Requirements

Materials characteristics, such as shelf life, special handling requirements, and remaining shelf life after arrival, directly influence the planning and management of the inventory. The company must know, understand, and manage these characteristics to avoid obsolete products and customer dissatisfaction.

Shelf life is an important factor of the materials. Depending on the product, some products may have a short shelf life or fast expiration date. However, in extreme cases, a long lead time leads to between the finished goods and the customer receiving the product, which may create a problem

with the product that expires and cannot be used. This means that mismanagement of shelf life and order-to-delivery process can lead to slow-moving and obsolete products (SLOBs), increased costs, and potential stockouts.

For companies dealing with materials with short shelf-life, it is essential to have the correct materials setup (e.g., set as made-to-order products) to have the right product strategy. It is also essential to have a robust product monitoring system to know its status and performance in the process. Accurate forecasting, based on historical consumption data and market trends, can help support decision-making by providing data about the situation to minimize the risk of having expired products in inventory and adjusting the material production strategy.

5.3.6.2 Inventory and Resources Management

Effective inventory and resource management is critical to ensure that materials are available or will be available when needed without overstocking the inventory. Factors such as constant communication and updating, safety stock reviews, and adjusting the materials requirement planning (MRP) system to real-life consumption and trends are ways to keep the inventory optimized.

One major issue identified is the lack of regular timely communication regarding product availability. For example, phased-out items or those with production issues should be communicated immediately to all relevant stakeholders via the system or a tracked method of communication. This ensures that all parties in the internal know which actions to prioritize, aware, and prepare so customers and the team are informed about the product availability; therefore, they can act accordingly to reduce the likelihood of order delays or cancellations.

Clear communication between the departments with the support of a system where all stakeholders can access real-time information easily will make a better way of working, streamline decision-making, and improve overall efficiency in the supply chain. According to Christopher (Christopher, 2011), reducing intermediaries in the flow of information minimizes delays and allows for faster decision-making, especially when urgent adjustments need to be made. This could be in the form of a system or platform where everyone can see the updated information on the relevant subject (e.g., available product, phased-out product, products that need to be aware of)

The management of safety stock is a key factor in ensuring uninterrupted supply. If stock is available, then the order can be easily fulfilled. The problem occurs when stock is unavailable—safety stock comes as a buffer. By forecasting, the possible requirements of products needed in the future can be predicted to keep up with the demand trends. Holding the right amount of sufficient safety stock may protect the company against unexpected demand fluctuations or other forms of supply chain disruptions. However, it is also important to balance safety stock levels to avoid over-stocking. A well-defined safety stock policy, scheduled reviews, updated information, and accurate forecast and consumption data can help maintain the optimum stocks and safety stocks to provide the company with a resilient supply chain.

The material requirements planning (MRP) system is vital to align production with forecasted demand and actual consumption patterns from historical data. If the MRP setup is not regularly updated or adjusted based on accurate data, it can lead to stock imbalances (overstocking or shortages). The misalignment impacts the company's ability to meet customer demand. Lead

time may increase as companies cannot predict and prepare for the upcoming demand, which leads to inefficiency and reactive production planning, and continuing this action may lead to loss of sales opportunities. To avoid this, MRP setup calculations need to be accurate. This implies how the MRP setup is calculated, whether the formula, variables, and data gathering and usage. Scheduled and regular review and adjustment of MRP setup (as well as other tools for planning) need to be informed by the latest forecast data (assumed forecast data is correct, or further research needs to be done for forecast data). This will help the company's manufacturing side to remain aligned with the market situation, minimizing lead times and improving customer satisfaction.

Lastly, keeping the material master data up to date cannot be overstated. Material data tells the planners the details of their product. Information includes product specifications, ABC XYZ categories, production lead time, minimum order of quantities (MOQ), lead times, and so on. An outdated database of the material master data may give incorrect input for planners when planning, where it can give the wrong decision-making that impacts delays in order fulfillment (shortages to demand) or production misalignment (excess goods produced) that further leads to missed business opportunities or customer dissatisfaction. Situations within the production sites are also included in the material master data update, which requires constant communication and the same frequency of understanding when updating information within the company's scope of regional supply chain. Establishing a regular scheduled review and update of the material master data is crucial to ensure accurate information input. Though it might still have room for error, minimizing adjustments during critical production times may help the company to perform better and ensure smoother operations across the supply chain.

5.4 Sub-Conclusion of Chapter 5

Chapter 5 conducted an in-depth analysis of the current situation of the order-to-delivery process, highlighting areas for improvement based on lead time assessment, process mapping, and identification of key factors.

The lead time assessment employed Pareto analysis and 5 Whys analysis, as well as data analysis and transformation through lead time decomposition. The Pareto analysis revealed that approximately 8% of products account for nearly 80% of lead time issues, pinpointing products that need targeted attention for significant impact. Lead time decomposition showed inconsistent production times, leading to the 5 Whys analysis, which identified the root cause as a lack of urgency in improvement efforts, resulting in the absence of measurement initiation. Addressing this is crucial for establishing data-driven decision-making before further actions are taken.

The process map evaluation revealed inefficiencies from manual data entry and room for more effective and efficient communication across stakeholders. It also indicated the need for aligning and standardizing workflows and documentation and detailed activity measurement. The potential for using visual trackers to monitor product flow was noted to enhance follow-up and proactive measures.

A cause-and-effect diagram categorized key factors affecting lead time under manpower, methods, machines, measurement, materials, and environmental influences from the interviews conducted during the lead time assessment, process mapping, and root cause analysis.

Emphasized solutions include clear roles and responsibilities, standardized documentation, mapped processes, a culture of continuous improvement, and better data management and measurement.

In summary, Chapter 5 identified critical issues that need addressing to optimize lead time performance. Solutions should involve well-documented processes, structured process improvements, better communication, proactive stakeholder management, clarity in roles and responsibilities, and data-driven practices to support sustainable process improvement.

6 Improvement to the Current Process

Chapter 6 presents improvement ideas based on the analysis in Chapter 5 and is organized into six (6) main sections: Section 6.1 outlines potential solutions identified from the analysis in Chapter 5, including an integrated supply chain grand design (Section 6.1.1), an end-to-end process map and measurement (Section 6.1.2), standardization of work documents, reporting methods, and communication (Section 6.1.3), fostering a continuous improvement culture (Section 6.1.4), and scheduled reviews for tool awareness and enhancement (Section 6.1.5). Section 6.2 evaluates the feasibility of these solutions through a SWOT analysis (Section 6.2.1) and a cost-benefit analysis (Section 6.2.2). Section 6.3 summarizes the proposed solutions, feasibility assessment, and prioritizes actionable strategies.

Section 6.4 details the implementation plan based on the principle discussed in the background study for the strategies, outlining immediate, short-, medium-, and long-term steps. Section 6.5 validates the findings by summarizing feedback from sessions with company representatives. Section 6.6 concludes with a summary of the proposed improvements, feasibility assessment, actionable strategies, implementation plans, and feedback validation for potential adoption by the company's internal team.

6.1 Possible Solutions to the As-Is Condition

From the analysis of the current situation, the most crucial problem is the lack of required measurement data, standardized process, and visual "one truth" process. Initial change management in the process that results in comprehensive current situation information and sufficient data is needed beforehand before deciding on other high investment and multi-intra-organizational decisions. By explicitly knowing the process of the tasks personally and throughout the stakeholders, problems and improvements may be more visible and acknowledged, and improvement can be discussed. Without data and standards, questions like "*How can we even judge the significance of the problem?*", "*To what extent do we want to target our improvement of the current process?" and "What are our benchmarks or standards to even call the process a problem in the first place?"* will emerge*,* but no robust data can support and answer the questions.

Referring to the 3P framework and Modern Marketing Management 4Ps, process precedes people. In other words, people must realize the need for improvement in the process before starting to improve it (Harrison & van Hoek, 2011). Theoretically, having all stakeholders or the company in a continuous mindset to work on the process is the ideal state. However, each person differs from one another in their principles, beliefs, and motivation in their daily job, which also includes continuous process improvement. Even if the team or some of the personnel, for instance, does not have a continuous improvement mindset, it is for the company's sake that the process happening in the team needs to be documented as part of their jobs to document and standardize their tasks. The decision of whether to improve the process or not depends on the actual data and the situation of the work. Thus, decisions are made based on a data-driven approach.

If the result or process deviates from how the standard should be, then it is a sign for the personnel, manager, or director to think of how to improve the system by changing or adjusting it. This may also work as a written trigger that some things need to improve. So, a top-down approach is used if a bottom-up approach does not work. However, this depends on the condition of the company. For our case study, it is observed that a top-down is expected to be the most effective approach for the improvement effort as the changes needed at the end would be inter-department movement. Therefore, moving the team with one vision and direction and coordinating the mission within the stakeholders would need a more systemic approach. Therefore, the solution is to have the measurement, mapping, and inter-stakeholder integration with initially a top-down approach, and if in the future, culture and mindset gradually agree with a continuous mindset. It is hoped to move because of a bottom-up mindset to capture more grassroots problems in the process, problems that may not been realized in the mesoscale. The process needs to be measured, mapped, and integrated, because,

1. If it is measured, its performance over time and the problems occurring can be identified
2. If it is mapped, the activities and the responsible parties can be determined.
3. If it is integrated, the component's measurements, locations, and methods can be understood.

To do this, initial change management with a focus on continuous improvement or incremental changes in the process is needed, as mentioned by Kettinger and Grover (1995) in Figure 17. Correlating it with the 3P framework (see Figure 14), people (correlates with Proposition 1 and Proposition 2) may create a good process (correlates with Proposition 3) and lead to the desired performance and environment (correlates with Proposition 4 and Proposition 5). Therefore, in relation to the framework, methodologies, and theories discussed while reflecting on the analysis of the current situation findings, several possible solutions are proposed to accommodate the improvement gaps observed in the process.

The solution proposed includes having (1) Integrated supply chain grand design; (2) End-to-end process map and measurement; (3) Standardization of work documents, reporting method, and communication; (4) Fostering a continuous improvement culture; and (5) Scheduled reviewing, awareness, improvement of essential tools. The proposed solution are derivatives in conducting the change management, which will be explained in more detail in the following subsections:

6.1.1 Integrated Supply Chain Grand Design

A comprehensive, integrated supply chain grand design is essential to improve the order-to-delivery process. The purpose of the grand design is similar to a “blueprint of the supply chain,” which is to give a clear vision, goals, objectives, and priority of the business unit for the agreed period. Therefore, the focus and direction of the company or a specific group of stakeholders are situated within the grand design. Also, the grand design may establish a transparent, systematic approach that aligns all stakeholders and promotes consistent execution across the supply chain. The approach includes a structured road map, detailed process maps, list of tasks and standardized work instructions, clear key performance indicators (KPIs), and continuous measurement strategies. Key components of the integrated grand design are outlined below:

1. **System requirements assessment with stakeholders**: Collaborate with all relevant stakeholders to define specific system requirements to ensure a shared understanding of

what the system must accomplish and what information needs to be available on the platform to effectively support the team's goals.

2. **Process and Activity Decomposition**: Clearly define all processes and activities involved in the order-to-delivery process cycle. Breaking down and defining the process helps identify each component more granularly, ensuring that all necessary actions are accounted for and standardized. This also relates to clarifying the roles and responsibilities of the stakeholders.
3. **Defining Key Performance Indicators (KPIs) and Measurements**: Establish or define specific KPIs to monitor performance, including systematically structured formulas to calculate each KPI. This clarity ensures that everyone understands the origin and intent of each KPI and how it relates to the overall process.
4. **Identifying Measurement Locations in the Process Map**: For each KPI, specify the exact points in the process where measurements will be taken, including the variables in the formula. This enables consistent data collection and supports accurate performance assessment and knowledge of how information is linked to one another.
5. **Consistent Data Measurement and Documentation**: Implement standardized data measurement practices, having the "one truth" definition of a variable, and document each variable's source in a work instruction manual. This guide ensures easy access to the data collection process, allowing stakeholders to refer to and locate necessary information seamlessly.
6. **Performance Analysis of KPIs**: Analyze the collected data on a regular basis to assess the effectiveness of each KPI. This analysis provides a benchmark for current performance and helps identify areas requiring improvement.
7. **Targeted Problem-Solving Based on Performance Data**: Based on KPI performance analysis, pinpoint specific issues within the supply chain. This targeted approach enables tailored solutions to lead-time problems rather than relying on a one-size-fits-all strategy. Addressing issues contextually allows for more efficient and effective resolution.
8. **Visual Representation of the Data**: Despite having the right data, it is also important to have the right visual representation of the data so that the stakeholders can easily grasp what is happening with the situation from the translated data format to the visual representation data. This also needs proper training in how to read the data in graphical and number format.
9. **Centralized and Accessible Data Storage**: Ensure that all collected data is stored in an accessible, organized format that allows for real-time updates and historical analysis. This centralized storage promotes transparency and facilitates ongoing review and process refinement.

With the integrated supply chain grand design, it is hoped that it can offer a comprehensive foundation for monitoring, analyzing, directing, and continuously improving the order-to-delivery process by fostering a well-coordinated, efficient supply chain framework that aligns with the company goals and to have a better understanding of the improvements in the strategic and operational level (Knowles, Whicker, Femat, & Canales, 2005).

6.1.2 End-to-End Process Map and Measurements

To support the integrated supply chain grand design, creating an end-to-end process map with clearly defined measurements across all stakeholders is critical. This process mapping approach provides visibility into each step of the order-to-delivery process and enables precise lead times

and KPIs tracking. By clearly identifying each activity and metric, this solution gives the basis for continuous performance improvement. Essential aspects of this solution are:

1. **Comprehensive Process Mapping and Required Measurement**: Developed a detailed and uniform format process map that covers the entire order-to-delivery process, incorporating inputs from all stakeholders and identifying each activity in the workflow. Within this map, measure lead times and other relevant KPIs to establish performance baselines for each stakeholder's role in the process. This ensures a holistic view of process efficiency and highlights improvement across the supply chain.
2. **Enhanced Visibility of the Product Journey**: With the mapped process and defined measurement, the actual position of the product in the process can be obtained. Therefore, all stakeholders know the overall status of the product. This transparency ensures that all stakeholders can easily understand and know the product's status and how the KPIs are translated from the process map or vice versa. With the progress in the journey of each order known, potential delays and bottlenecks can be identified as they arise, fostering proactive management, enhanced decision-making, and improved lead times or service level, ultimately improving customer service.

This end-to-end process map and measurement solution provides a detailed, technically oriented view of the entire supply chain. It gives the same understanding of the process and its definition of activities, ensuring each step is visible and measurable. The solution facilitates data-driven improvement and transformation by combining comprehensive mapping and digital tools, enhancing the overall process performance for all stakeholders involved.

6.1.3 Standardization of Work Documents, Reporting Method, and Communication

Standardizing the work process, reporting methods, and communication channels are essential to ensure consistency and accuracy throughout the order-to-delivery process. This part is integral to the people and process of the 3P framework, where the standardization of work instructions and agreed reporting methods are needed to work on in the process component. At the same time, communication, roles, and responsibilities must be clearly defined and agreed upon in the people component. Furthermore, key elements of this solution include:

1. **Standardized Work Documents**: Establish standardized, written, well-defined, quickly and easily followed, and understandable work processes, workflow, and work instructions for each step within the order-to-delivery process (e.g., Service level agreements, etc.). This standardization ensures that all stakeholders within the scope of the work documents follow a consistent method, which helps minimize output variability, reduces error in the process, and improves overall performance efficiency. The standardized work document content must also reflect the data and measurements obtained. Therefore, the message that is reflected in the document is correct and relevant.
2. **Improved Communication Protocols**: Enhance communication across stakeholders by setting clear guidelines and standard practices for information exchange. The roles and responsibilities of each stakeholders need to be written explicitly and updated when changes occur. These consistent communication protocols promote a shared understanding and

clear flow of contact references, allowing for faster issue identification, smoother handovers, and a more collaborative environment.

3. **A Unified Visual Platform for "One Source of Truth":** Implement a centralized visual platform that serves as the single source of truth and compilation of everybody's work on the team for all process-related data and KPIs. By providing real-time, easily accessible, and accurate insights, this platform ensures that all stakeholders within the process are working with consistent information. This centralization of information reduces confusion and incorrect information and supports informed and timely decision-making.
4. **Work and Problem Reference Handbook:** Establish and Develop a Work and Problem Reference Handbook inspired by aviation industry standards, such as the "Quick Reference Handbook" used by aircraft pilots. This handbook includes all the work instructions related to the stakeholder's operational tasks and projects. Therefore, when the stakeholder is performing tasks, it refers to this handbook while following the workflow of the order-to-delivery process.

   When a problem occurs, the stakeholders can directly follow the steps needed to mitigate the problem, which can be developed into a specific process related to the order-to-delivery process. This can also apply to the department's scope. This handbook should include:

   a. **Situational Checklist:** Create checklists to address various scenarios within the process, providing clear steps to address common issues and mitigate emergencies.
   b. **Dichotomous Key Structure:** The handbook is organized in a dichotomous key format or any sufficient direct and easily followed format, enabling users to quickly diagnose issues by following a decision-making flowchart or checklist.
   c. **Emergency SOPs Reference**: Similar to a pilot's emergency SOPs, such as "Checklist of Engine Restart," the handbook includes procedures for critical incidents, such as "Checklist for Supply Chain Disruption Mitigation: Raw Material Supplier" or "Checklist for Inventory Management: Overstocking." This ensures that employees have a structured response to different challenges.

   This solution requires more experience as it collects all the operational procedures, strategies, lessons learned, and best practices of the team. Therefore, collecting the information and producing the handbook may require more effort, but it can be prevented by working together collaboratively and with one motivation and direction.

These approaches leverage standardization to create a robust, consistent way of working, reporting, analyzing, and communicating across the organization. Therefore, it can be seen as having an "almost" error-proof output. By creating a culture that prioritizes standardization in the operational practices, shared information, and structured problem-solving flow, this solution supports a resilient, collaborative, and effective working framework in the order-to-delivery process and the working environment.

6.1.4 Continuous Improvement Culture

Establishing a culture of continuous improvement is essential for a sustainable, customer-centric supply chain. This approach emphasizes proactive enhancement of the processes, continuously maturing premature processes and improving mature processes, encouraging employees to embrace innovation always to give the best to the customers and improve their way of working. Adopting a continuous improvement culture strengthens customer loyalty and

mitigates the risks posed by potential market competition. By being a company that continuously improves to create an efficient and effective way of doing things, the company would perform better and be superior to competitors. The key elements to this solution include.

1. **Continuous Improvement Work Structure and Culture**: Shifting the organization's way of working from reactive "firefighting" to preventive and systematic improvement of a "continuous improvement" mindset. By fostering a culture of continuous improvement, employees are encouraged to proactively identify and resolve issues before they escalate by taking preventive actions through sound processes and mitigation notifications, which creates a more stable and resilient supply chain process. This approach promotes a long-term result over maintaining easy routines, driving sustained operational excellence.
2. **Customer-centric focus over competitor-centric focus**: "*How can we serve the customer better?*" This is the question that employees need to think about every day when they do their jobs. Therefore, their work will not just be a regular daily job but impactful work that creates satisfaction for the customer. While external competition may spur some companies to innovate, the primary focus should be on delivering exceptional service that places customer needs as the pivot. By understanding and meeting customer expectations, companies build lasting relationships and loyalty. This customer-centric approach drives meaningful innovations that enhance the customer experience and differentiate the company rather than simply reacting to competitors and problems. This is important, especially when the company's goal and priority is high-quality service. Emphasizing customer-centric focus over competitor-focused or other focused actions allows companies to set higher service standards, strengthening their goals and efforts in customer satisfaction.
3. **Data-driven culture**: "*You can improve what you can measure*". This quote directly states that to improve things, measurement is needed. The company cannot improve something without any standards or data on where it is currently. This goes to the culture that the mindset is to make decisions, improvements, and arguments based on reliable and correct data.

While perfection may be a never-ending journey, a continuous improvement culture embodies the commitment to consistently seeking better working methods. This mindset reinforces a company's dedication to excellence and fosters an adaptable, innovative workforce focused on delivering value to customers.

6.1.5 Scheduled Reviewing, Awareness, and Improvement of Essential Tools

To support a robust and adaptive supply chain process, it is essential to implement a structured schedule for reviewing, updating, and raising awareness of essential tools and technologies utilized. Regular evaluation and improvement help ensure that the processes remain practical and relevant to the workflow and align with market demands and the probability of organizational structure changes. The key elements of this solution include:

1. **Regularly Scheduled Reviews**: Conducting scheduled evaluations regularly (e.g., monthly, quarterly, semesterly, annually, etc.) or following major disrupting events can ensure a timely assessment of tools, strategies, work documents, and KPIs and prevent undesired impacts in the long term. Regular reviews help identify areas needing adjustment or improvement and

provide an opportunity to recalibrate the tools used based on recent performance data and the dynamic conditions of the business.

2. **Awareness of Tools and KPIs**: Tools and KPIs are only as good if known and utilized correctly. Embracing a high awareness of available tools and KPIs can help to optimize work further. However, promoting, learning, and understanding each tool's purpose and how-to-use KPIs are required. The relevance of the tools is also essential; therefore, it is important to use the right tool for the right purpose. Teams that are better equipped with these assets can leverage their resources to improve their performance within the company.
3. **Technology and Tools Optimization and Adjustment**: Enhance operational efficiency and effectiveness by optimizing essential tools and strategies, focus on replenishment strategy, product setups, reporting, and forecasting accuracy
    1. **Replenishment Strategy**: Adjust the Material Requirements Planning (MRP) system to better suit demand patterns, using either an MTO or MTS strategy based on consumption and value contribution. Selecting an appropriate replenishment strategy ensures that inventory aligns closely with demand, which minimizes inventory and maximizes availability.
    2. **Preventive Reporting Tools and Actions**: Implement reporting tools that support preventive actions. The stakeholders can use the same platform with the measurement and reporting method to address potential issues proactively rather than reactively. Preventive tools improve overall process stability, proactive company moves, and disruptions in advance.
    3. **Demand Forecasting Accuracy**: Improve demand forecasting methods to enhance accuracy. Demand forecasting accuracy may be monthly or annual. The company can prepare and anticipate incoming demand beforehand.
    4. **Uniformity of Tools Used**: The findings show that the systems used by different offices and departments are different. For example, in the regional market office, they used a different inventory system from the production facility in Europe. This difference is better to be aligned uniformly, so in the example that the regional market uses the same inventory management system with the production facility in Europe to align all the information by using the same integrated system, therefore the solution implementation is focused on developing only in one platform that can be used for all.

    From here, more ideas for further research on forecast accuracy, replenishment strategy, and system integration can be studied and worked on. Of course, the company needs clear direction if they want to improve these aspects. Otherwise, it will not become a priority work.

6.2 Feasibility Assessment of the Solutions

From the possible solutions in Section 6.1 that have been categorized by the period term, the feasibility of the solutions is assessed. The output of the assessment will consider two methods, which are a SWOT analysis of the company, specifically the observed stakeholders, and a simple cost-benefit analysis of the solutions proposed

6.2.1 SWOT Analysis

From the author's observations, a SWOT Analysis of the observed stakeholders is summarized in Table 7. The SWOT Analysis will be analyzed with the possible solution from Section 6.1 to see

the feasibility of the solution when taking account of the SWOT information and also what countermeasures are needed to be prepared so that the Strengths and Opportunities may support the solution and the countermeasure may be seen as industrial challenges from the weaknesses and threats that may affect the solution. Moreover, the matrix between the SWOT analysis and possible solutions with the components of SWOT analysis that may affect the solutions is concluded in a chart in Figure 36. The SWOT analysis may not represent the whole condition, but rather give a representative industrial challenge of the condition.

Table 7 SWOT Analysis of the Observed Stakeholders

Strength	**Weakness**
1. (S1) Experienced Workforce	1. (W1) Silo Process
2. (S2) Established Customer Base	2. (W2) Change Management Challenges
3. (S3) Existing Technology Infrastructure	3. (W3) Integration Driver
4. (S4) Commitment to Quality and Priority on Service	4. (W4) Limited Resources
	5. (W5) Skill Gaps
	6. (W6) Emphasizes Clarity
	7. (W7) Knowledge Transfer
Opportunity	**Threats**
1. (O1) Adopting Best Practices	1. (T1) Profitable Company
2. (O2) Customer Experience Enhancement	2. (T2) Turnover Rate
3. (O3) Technology-Driven Transformation	3. (T3) Organizational Changes
	4. (T4) Business Priority
	5. (T5) Technological Constraints
	6. (T6) Third-Party Collaboration

Based on Table 7, the explanation of the components in the SWOT Analysis of the business unit is shown in the following. The strength part comprises four (4) components, which are elaborated more below:

1. **(S1) Experienced Workforce**: The stakeholders have significant experience in supply chain management and operations, which can facilitate the implementation of new processes and improvements, especially in the daily operational tasks.
2. **(S2) Established Customer Base**: A loyal customer base provides stability and allows us to test improvements with known clients.
3. **(S3) Existing Technology Infrastructure:** The company already has established operational systems that can be leveraged for the proposed digital and data-driven solutions.
4. **(S4) Commitment to Quality and Priority on Service**: A strong focus on quality and customer satisfaction can drive the adoption of customer-centric and continuous improvement initiatives.

Next, the opportunity part comprises three (3) components, which are elaborated more below:

1. **(O1) Adopting Best Practices:** Implementing industry best practices and process improvement methodologies that are publicly available could improve operational efficiency and set the company ahead of competitors by having the correct implementation.
2. **(O2) Customer Experience Enhancement**: Focusing on improving customer service and loyalty through better processes can drive long-term business growth and capture more market share.

3. **(O3) Technology-Driven Transformation**: Leveraging existing technology with clear system requirements makes operations more effective, efficient, and scalable.

Next, the weaknesses comprise seven (7) components, which are elaborated more below:

1. **(W1) Silo Process:** Stakeholders may only know about their work and do not know what the other stakeholders are doing. By knowing what others are doing, at least when a problem comes and the diagnosis is because of a specific root cause, who needs to be referred is known for faster resolution. Also, better visual knowledge, integration, and an end-to-end process can help make inputs and escalation easier.
2. **(W2) Change Management Challenges:** The stakeholders might resist change, especially if new processes disrupt established routines or add more workload to their daily tasks.
3. **(W3) Integration Driver:** Most departments run in silos; therefore, a driver of the integration within the stakeholders is needed to coordinate the changes and improvements needed. The integration driver needs authority (power) to drive the improvement and agreement within the stakeholders effectively.
4. **(W4) Limited Resources:** Limited specialized staff and time availability can be seen as internal challenges. Specialized staff such as process engineers or continuous improvement analysts are needed to be present to supervise and control the progress of the implementation and work daily. Time availability relates to the quality of work, workload, and energy of the planners in each department. This could be a weakness as time is limited, and priority will probably be allocated to daily operational tasks rather than the project. This could slow down the implementation of the solution. Good management and workload distribution is needed so that enough time and workload can be allocated for this project.
5. **(W5) Skill Gaps:** Different stakeholders may have different hard skills. For the stakeholder to do their responsibilities on their daily tasks and projects, additional training may be required, such as process mapping creation and data and analytics. Otherwise, they may constantly need support from others, which also delays their colleagues' work.
6. **(W6) Emphasize Clarity:** Clarity on the goals, direction, vision, and target needs to be emphasized explicitly and quantitatively within the stakeholder's team. The direction of where the team wants to head is important. Roles and responsibilities need to be defined clearly so that the team knows who is doing what, what can be supported by the team, and stakeholders can be utilized as good as possible to reach their goals. So, the tasks that need to be done can be designated to the right person by adjusting the workload and tasks.
7. **(W7) Knowledge Transfer:** Knowledge transfer is important as the daily tasks may need to be carried out by the other team members when the main person doing the tasks is unavailable or leaves the team. Therefore, a complete handover, detailed training, well-structured onboarding, and standardized documented work documents are needed best to facilitate the knowledge transfer between the team members.

   For example, standardized work instructions mean that if the user follows the steps and processes in the work instructions, thus it will always give consistent output. For example, almost 90% or more of the necessary information is already there to be learned, and a minor portion of the training is to complete the overall knowledge transfer. It is also observed that overdependence on several employees is usually the case. Most of the work relies on the knowledge of one or several employees. If this employee leaves the team or is unavailable, the knowledge and tasks will also be gone. Standardization and guidelines always need

documentation and records of the knowledge of the tasks to be handed over or taken over by other employees assigned.

Lastly, the threats comprise six (6) components, which are elaborated more below:

1. **(T1) Profitable Company:** When a company is profitable, lean and other improvement methodologies may cease to be prioritized or even exist because they are in a comfort zone. Improvement is not an easy and comfortable task, but it needs to be done to stay ahead of the competition and be profitable. This goes in the direction of management and is further translated to the operational level.
2. **(T2) Turnover Rate:** Employee turnover rate relates to unemployment actions such as resignation or termination from the company. These actions may have negative effects, such as an increase in workload for the team or decreasing employee morale, which may affect the implementation and daily work of the project and team. Without good handover or knowledge transfer, this component may jeopardize the team's workflow and slow down processes internally.
3. **(T3) Organizational changes:** Organizational changes relate to the stability of the organization internally. These organizational changes may include cost reductions that lead to employee reductions and cost savings by changing priority and budget allocation. Organizational changes can reduce employee morale, motivation, and actions in the short— and mid-term.
4. **(T4) Business priority:** Business priority relates to the dynamic direction of the commercial side. If the business is not prioritized in one business unit, it may receive less attention and budget allocation, which can lead to fewer improvements or activities being emphasized.
5. **(T5) Technological Constraints:** When making the improvements, there might be ideas that could not be realized because of technological limitations. This may also make the improvement still doable and functional but not to the point of being optimized, effective, and efficient.
6. **(T6) External Collaboration:** After observing the process, there are influences also from stakeholders outside of the company (e.g., government institutions, logistics transport, shipping company) that can affect the data of the solution (e.g., lead time, location status, causes of delays, etc.). Information that the company needs but comes from external institutions may not be available due to confidentiality or other reasons. Therefore, certain adjustments, tolerance, and flexibility should be considered and incorporated into the solution implementation.

When looking at the SWOT analysis of the departments and combining it with the possible solutions, it is shown how the strengths and opportunities can support the solutions and how to countermeasure the weaknesses and threats. A possible solution is indirectly helping to improve the weaknesses and effects of the possible threats. Some key components were observed to play a significant role in implementing the solution based on the SWOT Analysis. The analysis of the SWOT and Solution Matrix concluded with a checklist chart, shown in Figure 36, to show the connection between the SWOT and where it contributes to the possible solution, which will be elaborated more in the following.

		Solution				
		P1	P2	P3	P4	P5
		Integrated Supply Chain Grand Design	End-to-End Process Mapping and Measurements	Standardization of Work Documents, Reporting Method, and Communication	Continuous Improvement Culture	Scheduled Reviewing, Awareness, and Improvement of Tools
Strength						
S1	Experienced Workforce					
S2	Established Customer Base					x
S3	Existing Technology Infrastructure					
S4	Commitment to Quality and Priority on Service				x	
Opportunities						
O1	Adopting Best Practices					
O2	Customer Experience Enhancement				x	
O3	Technology-Driven Transformation					
Weaknesses						
W1	Silo Process					
W2	Change Management Challenges			x		x
W3	Integration Driver	x	x			
W4	Limited Resources			x		
W5	Skills Gaps					
W6	Emphasizes on Clarity	x	x	x		
W7	Knowledge Transfer			x		
Threats						
T1	Profitable Company				x	
T2	Turnover Rate			x		
T3	Organizational Changes					
T4	Business Priority					
T5	Technological Constraints					x
T6	External Collaboration		x			

	Give Effect
x	Give Effect and Key Components

Figure 36 SWOT Analysis and Possible Solution Matrix

Solution 1 (P1): Integrated Supply Chain Grand Design

The implementation of an integrated supply chain grand design is supported by the company's strengths, including an experienced workforce (S1), existing technology infrastructure (S3), and a solid commitment to quality and priority on service (S4). The experienced workforce can provide valuable insights from various departments, contributing essential information on what needs to be done, potential challenges, and areas for improvement. The existing technology infrastructure allows the company to utilize current tools and systems to develop an integrated grand design with advanced digital outputs and comprehensive information gathering. Furthermore, the commitment to quality and service drives a team culture focused on continuous enhancement, ensuring that any new processes will align with the organization's dedication to customer satisfaction and operational excellence.

Opportunities such as adopting best practices (O1), customer experience enhancement (O2), and technology-driven transformation (O3) further strengthen the feasibility of this solution. Leveraging best practices enables the adoption of proven methodologies for defining the grand design, resulting in accurate strategic planning and minimized risk of poor decision-making. Focusing on enhancing customer experience motivates creating an integrated supply chain design that prioritizes customer-centric improvements. Technology-driven transformation ensures that modern operational tools can support process optimization and facilitate effective information sharing, making this solution feasible and aligned with current industry standards.

However, specific weaknesses and threats could hinder full implementation. The integration driver (W3) and the emphasis on clarity (W6) are critical areas of concern. Effective integration requires collaboration across departments, and coordination may be challenging without a designated integration leader with sufficient authority. Emphasizing clarity is also crucial, as stakeholders need to understand the grand design's purpose, qualitatively and quantitatively, to ensure alignment in objectives and outcomes. Other weaknesses include silo processes (W1), change management challenges (W2), limited resources (W4), and skill gaps (W5). Silo processes can limit knowledge sharing between stakeholders, while change management challenges and limited resources may delay progress. Skill gaps could further slow implementation unless training programs are implemented to upskill employees.

Threats such as a profitable company culture (T1), which may deprioritize improvement efforts, organizational changes (T3), technological constraints (T5), and external collaboration issues (T6) could also impact feasibility. Addressing these challenges requires thorough planning, phased execution, clear communication, and strong project management. Overall, the integrated supply chain grand design solution has **medium-high feasibility**, supported by strengths and opportunities, with a strategic approach needed to effectively manage potential weaknesses and threats.

Solution 2 (P2): End-to-End Process Map and Measurements

The strengths of the company, such as an experienced workforce (S1), an established customer base (S2), existing technology infrastructure (S3), and a commitment to quality and priority on service (S4), significantly support the feasibility of implementing an end-to-end process map and measurement system. The experienced workforce can provide comprehensive insights into current processes and help identify areas for improvement, ensuring that the mapping is

accurate and reflects actual operations. The established customer base provides a stable platform to pilot and test the new process mapping, allowing for iterative refinement before full implementation. Leveraging existing technology infrastructure ensures that the required data collection and analysis can be carried out effectively, while a commitment to quality motivates continuous process monitoring and improvements.

Opportunities such as adopting best practices (O1) and technology-driven transformation (O3) further bolster the feasibility of this solution. Utilizing industry best practices enables the stakeholders to establish robust, proven methodologies for mapping processes and measuring performance. The focus on technology-driven transformation aligns well with the company's existing technology infrastructure, making integrating digital tools and streamlining processes for real-time visibility easier. However, weaknesses such as silo processes (W1), change management challenges (W2), and limited resources (W4) pose potential obstacles. Teams working in silos may struggle to share knowledge or integrate their processes, while change management challenges could hinder acceptance of new practices. Limited resources, including time and specialized staff, may slow down the project if not adequately addressed through strategic resource allocation and training.

Threats like high turnover rates (T2), organizational changes (T3), technological constraints (T5), and the need for external collaboration (T6) can impact the success of this implementation. Employee turnover could disrupt knowledge continuity and delay project progress, while organizational changes may shift focus or reduce available resources. Technological constraints could limit the functionality of the mapped processes, preventing full optimization. External collaborations with stakeholders such as logistics companies and government institutions may introduce delays and data access challenges. Despite these challenges, the feasibility of implementing an end-to-end process map and measurement system is **medium-high feasibility**, supported by strong internal strengths and opportunities that, with strategic planning, can mitigate potential weaknesses and threats. Moreover, training and a focus on incremental improvements can help address the concerns.

Solution 3 (P3): Standardization of Work Documents, Reporting Method, and Communication

The strengths of an experienced workforce (S1), existing technology infrastructure (S3), and a commitment to quality and priority on service (S4) make standardized work documents, reporting methods, and communication highly feasible. The knowledgeable team can help develop comprehensive work instructions and reporting standards that align with best practices. The existing technology infrastructure facilitates digital documentation and reporting, making standardization more efficient. A commitment to quality ensures that employees prioritize consistency and accuracy in their work, aligning to create a standardized environment.

Opportunities such as adopting best practices (O1) and leveraging technology-driven transformation (O3) enhance the feasibility of implementing standardization in work documents, reporting methods, and communication. Best practices support the development of uniform templates and documentation methods that align with industry standards, ensuring consistency and reliability. Leveraging technology helps streamline the distribution and updating of standardized documents and promotes clear communication across stakeholders.

However, the feasibility of this solution faces challenges due to weaknesses such as change management challenges (W2), limited resources (W4), skill gaps (W5), an emphasis on clarity (W6), and knowledge transfer (W7). Stakeholders may resist new processes that disrupt established workflows or add to their workload and limited time and staffing may delay the initial implementation. Skill gaps may necessitate training programs to ensure all employees can effectively follow the new standards. Without a strong emphasis on clarity, roles, responsibilities, and output requirements may be poorly understood, leading to inconsistent adoption. Knowledge transfer is also crucial, ensuring that the work documents and reporting methods capture essential information. While some tacit knowledge may be challenging to document, it is vital to include all actionable and explicit details in the documents to maintain continuity and support team effectiveness.

Threats such as high turnover rates (T2), organizational changes (T3), and shifting business priorities (T4) could impact implementation. Employee turnover may disrupt training continuity and adherence to standardized practices, but it could also serve as an opportunity to test the effectiveness of standard work instructions with new employees. Organizational changes might redirect focus or reduce resource allocation for this initiative, and shifting business priorities could decrease emphasis on standardization if other projects take precedence. Despite these challenges, the solution's feasibility remains **highly feasible** due to the alignment between internal strengths and external opportunities. Potential weaknesses and threats can be managed with proper planning, clear communication of the long-term benefits, and a gradual rollout of standardized documents. Additionally, the development of standard templates, whether created from scratch or adapted from existing templates, and clear report content requirements are essential prerequisites. It is also crucial for these documents to be controlled to maintain their standardization. Furthermore, reports and documents should be visual, ensuring that operational input tasks are clearly defined and consistent, with instructions that guide users on specific buttons and descriptions to be clicked for uniformity.

Solution 4 (P4): Continuous Improvement Culture

The company's commitment to quality and priority on service (S4) is a key strength supporting fostering a continuous improvement culture. This strength creates a foundation for encouraging employees to adopt proactive problem-solving and continuous process enhancement, ultimately leading to sustained performance improvements. Opportunities such as customer experience enhancement (O2) further reinforce this solution, as focusing on continuous improvement can directly impact customer satisfaction and loyalty, contributing to long-term business growth.

However, weaknesses such as change management challenges (W2), and knowledge transfer (W7) pose significant obstacles. Resistance to change can impede the adoption of a continuous improvement mindset, mainly if employees are accustomed to static routines. Ensuring effective knowledge transfer is also critical, as overreliance on specific stakeholders without comprehensive documentation and training can hinder progress and sustainability. Addressing these weaknesses requires strong leadership, targeted training programs, and a well-structured approach to change management.

Threats such as the company's current profitable state (T1) and organizational changes (T3) further complicate implementation. A profitable company may deprioritize improvement initiatives, as the urgency for change may be perceived as lower. Additionally, organizational changes such as restructuring or budget reallocation can affect employee morale and reduce focus on long-term cultural initiatives. Due to these combined factors, the feasibility of establishing a continuous improvement culture is assessed as low to medium feasibility. While a solid commitment to quality provides a promising starting point, overcoming change resistance and ensuring consistent knowledge transfer is critical to successful implementation.

Solution 5 (P5): Scheduled Reviewing, Awareness, and Improvement of Tools

The company's strengths, including an experienced workforce (S1), an established customer base (S2), existing technology infrastructure (S3), and a commitment to quality and priority on service (S4), make the implementation of scheduled reviewing and tool improvement highly feasible. The stakeholders can conduct reviews and assessments efficiently while the existing technology infrastructure enables data collection and analysis to monitor tool effectiveness. The established customer base provides a reliable environment to gauge the impact of tool improvements on service quality, and the commitment to quality ensures a focus on consistently refining processes.

Opportunities such as adopting best practices (O1) and technology-driven transformation (O3) support this solution. Utilizing industry best practices ensures that review and improvement processes are effective and standardized while leveraging technology, which enhances the automation, scheduled triggers, and efficiency of regular assessments. However, weaknesses such as change management challenges (W2), limited resources (W4), skill gaps (W5), and the need for clarity (W6) could impede progress. The team may need to manage resistance to new review processes, ensure time and personnel are available for these activities, and train employees to develop relevant analytical and process management skills.

Threats such as shifting business priorities (T4), technological constraints (T5), and external collaboration (T6) may also affect implementation. Business priorities can change, potentially diverting resources and attention from continuous review initiatives. Technological limitations could restrict the extent of the improvements made, while external collaboration challenges may delay data collection or analysis. Overall, the feasibility of implementing scheduled reviewing, awareness, and improvement of tools is **high feasibility**, provided that sufficient resources, training, and strategic planning are in place to effectively manage weaknesses and external threats. Moreover, prioritizing critical areas for review would make the solution more effective and impactful.

Overall Feasibility Recommendations, based on SWOT Analysis:

1. **High Feasibility**: (P2) End-to-End Process Mapping and Measurement; (P3) Standardization of Work Documents, Reporting Method, and Communication; (P5) Scheduled Reviewing, Awareness, and Improvement of Essential Tools.
2. **Medium-High Feasibility**: (P1) Integrated Supply Chain Grand Design is feasible but requires a phased and resource-conscious approach.
3. **Low-Medium Feasibility**: (P4) Cultivating a Continuous Improvement Culture is valuable, but it may require more time and focus on change management to become effective.

The company should prioritize solutions that align with its strengths, such as existing knowledge and technology, while addressing weaknesses like resource constraints and change resistance through strategic planning and phased implementation.

6.2.2 Cost-Benefit Analysis

A simple assessment based on observations will be done for the cost-benefit analysis. Therefore, to get a glimpse of whether the solution gives more or less benefit than the assumed cost. Further cost-benefit analysis with a costing method can be done for future research. Using the Cost-Benefit Matrix from Six Sigma Methodologies, the solutions can be plotted based on the cost-benefit into the four (4) quadrants. The cost-benefit matrix is displayed in Figure 37, with a detailed explanation of the analysis following.

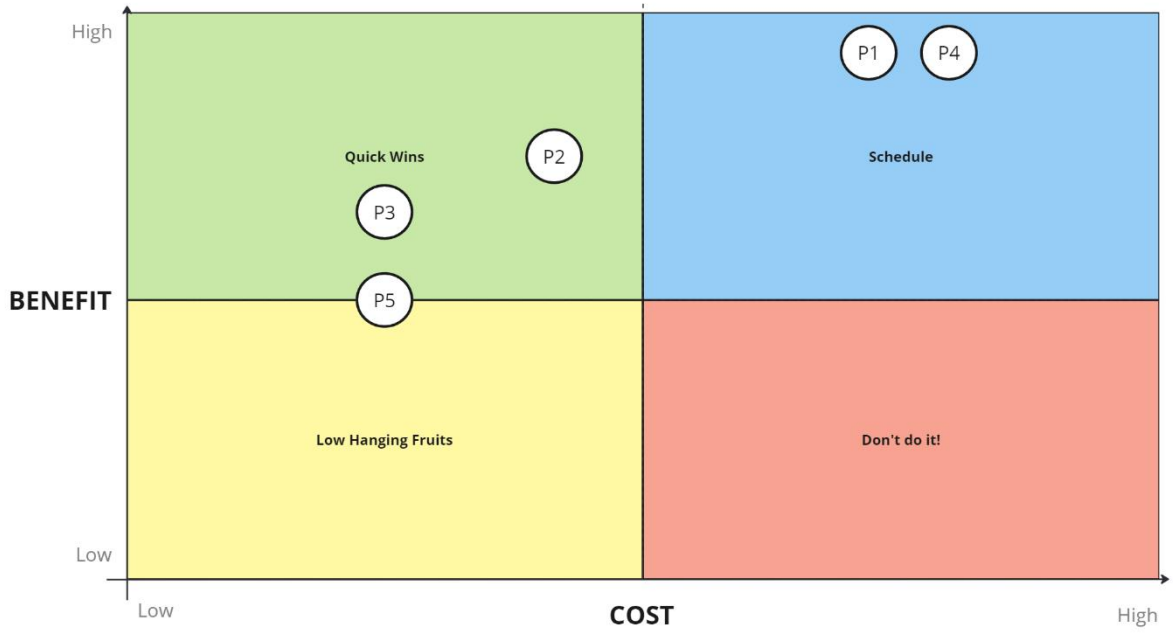

Figure 37 Cost-Benefit Matrix for the Five (5) Possible Solutions

Solution 1 (P1): Integrated Supply Chain Grand Design

Implementing an integrated supply chain grand design would involve upfront costs, including supply chain diagnostics, the possibility of process redesigning, and extra staff training to comply with the manpower requirements. Also, the time required to collect and connect all these data is included as costs in a more intangible way. These costs may disrupt operations as employees involved need to adapt to a new way of working. Additionally, the company may need to allocate resources or bring in external support, such as consultants, to develop detailed current process and opportunity diagnostics, including process maps, financial conditions, and supply chain efficiency (cost and performance) status, which require a high level of collaboration and expertise.

However, the benefit of this comprehensive approach is substantial. An integrated design can align all the known resources and status of the company with the opportunity to improve a targeted goal in the roadmap and organizational goals. It may help streamline supply chain operations, improve visibility across all processes, and enable more accurate and data-driven

decision-making. It may lead to cost savings and better resource utilization in the long term by enhancing efficiency and reducing cumulative waste over time. Furthermore, having a clear roadmap, directions, and system requirements ensures all stakeholders are aligned and well-aware, enhances collaboration and improves overall performance.

The feasibility of this solution in a cost-benefit matrix is rated as **medium-high cost** with **high benefits,** which is **medium-high feasibility**. While having more upfront costs, the medium-long term benefits will result in significant benefits, making it a worthwhile investment. This solution is to have a grand map of how the company wants the supply chain to head; the company needs to understand its current position, where it will head, and what possibilities can be achieved. The most important is to have an integration driver and a clear vision that is translated into reality. A phased approach, explicit decomposition, and structured approach must be made for step-by-step completion supported by careful change management to ensure smooth execution.

Solution 2 (P2): End-to-End Process Mapping and Measurement

Implementing an end-to-end process mapping and measurement involves moderate costs, primarily in training staff on thorough and detailed end-to-end process mapping and measurement. If they are capable enough, then less time will be needed to execute the process of mapping and measurement. Also, measurement can be done manually by inputting every order; this is the case if the available tools cannot capture the needs of stakeholders or they do not know how to use them. However, it will not be the most efficient method of working. Therefore, the solution is straightforward and doable if the team knows how to do it, and the information needed is known. Additionally, integrating data from various sources may require system enhancements and potentially add extra costs that need to be addressed. Ideally, every team representative can map their processes in the standard and agreed way. However, if this is not the case, someone would need to map the process with knowledge and support from the representative, or the representative would need to be trained to do the process mapping. Here, time and knowledge would be the costliest components.

Despite these costs, the benefits are clear and impactful. The solution enhances visibility into every step of the supply chain, at least to the order-to-delivery process in the regional market, enabling better control and proactive steps. By measuring lead times and other key performance indicators to the core and with the help of data analysis, the company can identify bottlenecks, re-innovating ways to reduce inefficiencies and make more informed decisions. The improved transparency and real-time data facilitate continuous performance tracking.

Overall, this solution is **highly feasible** with **medium cost** depending on the system requirements and **medium-high benefit**. Investment in process mapping and measurement tools also yields substantial and measurable improvements in process and performance. The existing knowledge from the experienced workforce combined with the opportunity to improve significant efficiency gains support the implementation of this solution. With proper planning, resource allocation, and clear vision from the management level, the company can effectively enhance process performance while keeping costs manageably low.

Solution 3 (P3): Standardization of Work Documents, Reporting Method, and Communication

The costs associated with standardizing processes, reporting methods, and communication in practice are relatively low. Expenses such as time and detailed knowledge of the work may be more intangible. Therefore, developing and implementing standardized work instructions with an agreed template would require time as a key cost. As for the reporting method and system requires more intangible costs, which are agreement and unification of understanding within the different departments along the process. This also includes the required training to use the reporting method fully. Resistance to change will be considered a cost, and addressing this may require further investment or cost in change management strategies and ongoing support to ensure adoption and engagement from staff exist. Besides that, a clear list and direction of what needs to be done can also reduce the cost of not knowing what needs to be done or the priority of the work. Good leadership and management to strictly decide the work that needs to be done and when it needs to be done is crucial to having a low-cost and high-benefit solution to finish.

The benefits of this solution are substantial, as it leads to greater consistency of performance through a standardized work process, which will be reflected through reduced error, less variability in the result, and, eventually, more efficient operations. A unified approach to communication, including roles and responsibilities, updating, and problem resolution, enhances team collaboration and ensures that information is clearly and reliably shared in real time. Standardization also simplifies onboarding and training for new employees, reducing the time and cost of having the required knowledge for the job. Additionally, having a collection of this standardized work document in a reference handbook inspired by the aviation industry ensures that teams can quickly refer to the guidebook for information and issue resolution.

Overall, the solution is **highly feasible**, considering **relatively low-medium cost** by combining intangible cost and monetary cost while delivering **medium benefits** with the prospect of delivering significant productivity and quality improvements eventually. The company's existing focus on quality and operational efficiency supports the adoption of standardization of its process in practice. By emphasizing the benefits of a standardized process and clear communication, the company can overcome potential defects and see quick wins from this cost-effective implementation.

Solution 4 (P4): Continuous Improvement Culture

The cost of fostering and implementing a continuous improvement culture will be challenging, as people have used current habits for many years, which are also engrained in how they do work and decision-making. This solution may require a long-term and ongoing investment in mindset and actions alignment, employee training, development of programs and initiatives, and setting examples at the management levels. The initial cultural shift may result in resistance and decreased productivity as employees adjust to the new normal and expectations. Additionally, resources must be dedicated to the operational level to support and encourage the continuous improvement culture, and according to the 3P framework, it all starts with the people.

The benefits of this cultural transformation are long-term and bring valuable lessons along the way. A continuous improvement of culture promotes operational resilience, adaptability, and sustainability. Employees become more engaged and motivated to proactively identify and solve

problems or improvements. In addition, by having a customer-centric focus, the work done by the employees always puts the customer in the center by also considering the possibilities of the company, which gives better service, customer satisfaction, and eventually loyalty.

Overall, despite having **high benefits**. The feasibility of this solution seemed to be **low-medium feasibility** as changing culture will be more challenging and require more extended time than other proposed solutions and cannot be judged only by a cost-benefit analysis. Other factors play a role in the implementation of this solution. Strong leadership and continuous support are essential to embed this solution successfully. This solution also requires an environment to support it; if only several employees are placed within a pool of continuous improvement, it will not work. Therefore, the environment must also support a continuous improvement culture. A gradual and well-structured approach of continuous improvement culture initiatives partnered with effective change management can ensure the organization moves towards a proactive and continuous improvement focus team. These barriers may result in a **medium-high cost** of implementation.

Solution 5 (P5): Scheduled Reviewing, Awareness, and Improvement of Tools

The costs of scheduling regular reviews and awareness of tools can be seen as low-cost. These actions indirectly benefit the improvement of tools or any work documents or any process, but they become a trigger to evaluate the tools in the organization. The actions can be reviewing, auditing, upgrading or replacing or adjusting outdated systems or tools, and dedicating time to thoroughly evaluate the metrics and their performance. These intangible and tangible expenses may impact productivity due to the time spent on the reviewing sessions. Therefore, reviewing too often will not be efficient. Depending on the tools, the review's schedule and frequency must also vary. Additionally, maintaining awareness and training sessions requires ongoing resource allocation, such as inviting experts to training, giving them time to learn the tools, etc.

The benefit of this approach is that it ensures the correctness of the tools and processes remain aligned with the strategic goals and objectively reflects the dynamic situation of the market. Regular evaluations allow the company to stay relevant to the current situation from the data or the algorithm or formula to give the result they need to process further to comply with the market demand. Awareness of tools and KPIs may empowers the stakeholders to utilize resources effectively. Sometimes, the stakeholders do not even know they already have specific tools because they are unaware of what the company has. Having a method to give information and awareness to the employees regarding what assets, tools, or knowledge the company will have benefits productivity. Improving tools such as demand forecasting, inventory management strategies, and current workflow can lead to better demand planning and overall performance. By doing this thesis, the company is trying to assess what went wrong in the order-to-delivery process. This is also an example of how reviewing can make awareness of what process can be improved or what the problem is in the process. Overall, this proactive maintenance approach supports long-term stability and operational excellence by creating routines to improve if there are continuously inefficient processes in the system.

This solution has a low-medium cost and medium benefits depending on the actions. **High feasibility** is rated for this solution. As the cost of conducting reviewing and improvement is moderate, the benefits of these actions can outweigh the value generated from realizing and

improving tools and processes. The company can implement this solution without significant financial expenses by categorizing and prioritizing critical areas for regular review and utilizing existing technology. However, good knowledge of how things work, leadership management, and setting priorities is needed to treat the needed processes effectively. Otherwise, the scheduled review and improvement are just formalities without making it effective to realize potential improvements.

6.3 Actionable Strategies for the Improvement Solutions

The SWOT and cost-benefit analyses provide insights into the feasibility of the proposed solutions and their potential as actionable strategies for improving the order-to-delivery process in the regional market. Table 8 summarizes the feasibility assessment from Section 6.2, with color-coded indicators showing the cost and benefit balance for each solution. A "Green" rating indicates high feasibility and ease of implementation, "Light Green" suggests medium-high feasibility with essential support needed, and "Orange" implies low-medium feasibility, requiring extensive support and focus.

Table 8 Prioritization of Solutions

	SWOT	**Cost-Benefit**		
	Feasibility	Feasibility	Benefit	Cost
Solution 1	Medium-High	Medium-High	High	Medium-High
Solution 2	High	High	Medium-High	Medium
Solution 3	High	High	Medium	Low-Medium
Solution 4	Low-Medium	Low-Medium	High	Medium-High
Solution 5	High	High	Medium	Low-Medium

The summary of solutions based on feasibility indicates the actionable strategies:

1. **Immediate actions**: Standardization of Work Documents, Reporting Method, and Communication (Solution 3), Scheduled Reviewing, Awareness, and Improvement of Tools (Solution 5), End-to-End Process Map and Measurement (Solution 2).
2. **Require planning and coordination**: Integrated Supply Chain Grand Design (Solution 1)
3. **Further assessment and phased implementation**: Continuous Improvement Culture (Solution 4)

Prioritization of immediate actions is informed by the cost-benefit analysis, which suggests prioritizing lower-cost, high-benefit solutions. Solution 3 (standardization of work documents) and Solution 5 (scheduled reviewing) are identified as the highest priorities, followed by Solution 2 (end-to-end process mapping and measurement), which, while beneficial, incurs higher costs. The integrated supply chain grand design (Solution 1) requires extensive planning and coordination due to higher costs despite its benefits. Implementing a continuous improvement culture (Solution 4) demands significant effort and long-term commitment, as changing organizational culture is complex and requires strong leadership.

Christopher (2011) states that improving process excellence leads to a higher competitive advantage, assuming product excellence remains constant. Enhanced process performance enables quicker responses to customer needs and process issues, facilitating prompt mitigation

and reducing lead times. Shorter lead times translate to reduced inventory needs, minimized forecasting errors, and less safety stock, which optimizes production capacity for essential products and reduces delivery costs.

$$Competitive\ Advantage \uparrow = Product\ Excellence\ x\ Process\ Excellence \uparrow$$

Initial findings aimed to improve the company's order-to-delivery process in the regional market by enhancing lead times. However, the analysis revealed that lead time is an outcome of the overall process. The proposed solutions, combined with actionable strategies, aim to create more excellent value for the company by increasing the willingness to pay (WTP) and lowering the willingness to sell (WTS) (Oberholzer-Gee, 2021). By structuring processes to improve visibility and identify root causes, the probability of resolving process issues increases, leading to better lead times, higher customer satisfaction, and improved service. Additionally, better processes create a positive work environment for employees, boosting job satisfaction and reducing the WTS, provided compensation remains stable. In summary, by increasing WTP and lowering WTS, the company enhances its overall value creation.

From these actionable strategies, if implemented, it is hoped that the company's new relative position in the value-cost advantage matrix of Figure 38 can shift to a more cost-competitive position (shift to the right) by improving the supply chain performance.

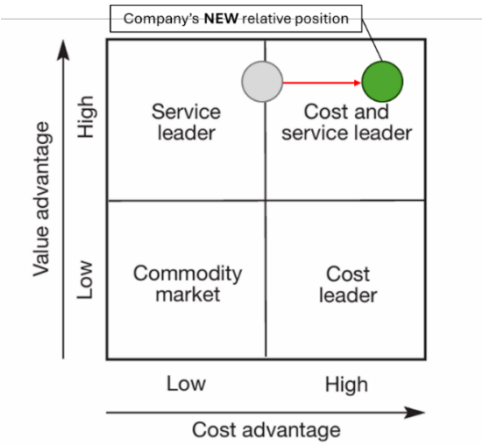

Figure 38 The company's new relative position in the value-cost advantage matrix after the implementation of the actionable strategies.

6.4 Implementation Plan of the Actionable Strategies

From Section 6.3, the actionable strategies and their priority to answer the author's concerns about the current findings are understood. In this section, the focus is on seeing how the actionable strategies can be planned accordingly to be implemented. After generating solutions, the focus shifts to implementing them.

From the insights about implementation planning by Harrison and van Hoek (2011), Iacoviello et al. (2024), and correlation with the 3P framework, the development of an implementation plan based on the characteristics of the solution, priority, and duration are elaborated below. In addition, essential notes from observation, interviews, and feedback are included to enrich the implementation plan and its content. The solution will be focused on the order-to-delivery

process to the regional market. However, implemented to another scope in the team is also possible with certain adjustments:

1. **Immediate actions** (<1 month):
    1. Understand the need to change (Harrison & van Hoek, 2011).
    2. Communicate the plan through the stakeholders to raise awareness.
    3. Understand that the short-, medium-, and long-term solutions can be done in parallel with different PIC (person in charge) and delegation.
2. **Short-term** (1-6 months):
    1. Standardization of Work Documents, Reporting Method, and Communication:
        1. The team will list all tasks in the team.
        2. The PIC will prioritize the tasks involved in creating or updating work documents and set clear roles and responsibilities for them.
        3. Create a system requirement and template (e.g., Required information in the document, uniform template for the document, etc.).
        4. Set deadlines and milestones for the tasks.
        5. Create standardized work instructions, reporting methods, and communication flow.
        6. Consult with the process excellence expert of the company for the correct method of approach
        7. Evaluate and revise through schedule reviewing.
        8. Do for all tasks within the team scope.
    2. Schedule Reviewing, Awareness, and Improvement of Tools:
        1. After all the tasks are listed (and while the work documents are standardized), make schedules, by agreement with the team, to evaluate and assess the work documents/tools regularly (e.g., monthly, quarterly, semester, annually, etc.).
        2. Understand the current situation, actual process, and work documents/tools.
        3. Analyze and identify problems that occur from the comparison.
        4. Depending on the problem, select appropriate tools, methods, and teams to address the problem.
        5. Create a plan and/or resolve the problem (e.g., updating work instructions, improving tools, adjusting numbers, etc.).
        6. Update the findings to the team.
        7. Prepare for the next evaluation schedule or emergency reviewing initiative (if a significant problem occurs before the scheduled reviewing).
        8. Create, update, and share a list of tools available within the team/department/business unit every month to raise awareness of available tools that can be utilized.
    3. End-to-End Process Mapping and Measurement:
        The key question for supply chain management is how to measure time within the network. The answer lies in recording the time taken to complete each activity, with the first step being a detailed understanding of the activities involved. Supply chain mapping, or process mapping, generates visibility into the processes within the

supply chain, allowing for benchmarking and comparison with similar processes (International Organization for Standardization, 2015).

The inspiration from Harrison and van Hoek (2011) about the outline of the key stages of time-based process mapping and from the DMAIC framework from Six Sigma methodologies. A tailor-made implementation plan for an end-to-end process mapping and measurement to suit our needs and the condition of the environment. Therefore, the steps needed for the implementation include:

1. Define
    1. List all processes in the business unit.
    2. See the performance of the processes.
    3. Prioritize processes to be improved based on performance.
    4. Select the process to be mapped.
    5. Create a task force to oversee the mapping process.
    6. Set clear goals, targets, roles and responsibilities, and commitment within the team.
2. Measure
    1. Collect data on the current processes and measurements.
    2. Flowchart the process to visualize the workflow.
    3. Construct a time-based process map to identify inefficiencies.
3. Analyze
    1. Distinguish between value-adding and non-value-adding activities.
    2. Analyze the process through the standardized work instructions. Compare with actual performance.
    3. Depending on the problem, identify root causes/bottlenecks/defects using the right tools.
4. Improve
    1. Generate solutions for process improvement.
    2. Select solutions.
    3. Plan implementation.
    4. Test the solution.
5. Control
    1. Evaluate and update improvement on the process documentation.
    2. Schedule reviewing, awareness, and improvement of tools regularly.

Using tools like BPMN diagrams, organizations can help map processes that include relevant stakeholders and their activities and to improve clarity and communication. This process helps highlight what needs to be done and who is responsible for each step, making the system more transparent.

3. **Medium-term** (6-12 months):
    1. Integrated Supply Chain Grand Design:
    This can be executed as a pilot project within an agreed scope in the company before scaling up to a higher level. Implementing the integrated supply chain grand design will be more complicated than the short-term implementation and will require more project management expertise. The timeline will mainly cover:

1. Project Initiation and Planning (Month 1-2):
    - Objective: Create a foundation for the project and ensure all stakeholders agree and are aligned.
    - Activities:
        - Form a dedicated project team that may include for example, supply chain managers, IT specialists, process improvement experts, daily planners, etc.
        - Do stakeholder analysis and stakeholder engagement.
        - Conduct a project kick-off meeting to establish the background, goals, timelines, roles and responsibilities, vision, and mission of the business unit that is translated from the organizational goals.
        - Develop a detailed project plan that outlines the phases, key milestones, and resource allocation.
        - Discuss the possibility of data and constraints that may be known beforehand from each function/department.
    - Deliverables: Detailed project timeline, project brief (including strategy and planning of the project)
2. System Requirement and Design (Month 2-4):
    - Objective: Define the system requirements and design the framework for the grand design.
    - Activities:
        - Collaborate with stakeholders to gather detailed system requirements that match each department's needs, ensuring alignment between departments and organizational goals.
        - Designing the integrated supply chain grand design framework, including what information is required for the team, process maps, data measuring plan, document standardization, KPIs, performance targets, and goals.
        - Define the KPIs and their calculation formulas to integrate and synchronize the information with the location where the data can be collected, ensuring clarity and consistency of definition across the organization.
        - Map and measure the agreed current processes.
    - Deliverables: Design requirement and objective (DRO) document, system requirement and design document, process maps, the initial design of the integrated supply chain grand design framework, KPI and measurement definitions.
3. Technology and Infrastructure Setup (Month 4-7):
    - Objective: Implement the system requirements to available technologies and ensure the infrastructure supports the new framework
    - Activities:
        - Set up supply chain management systems (e.g., SAP, etc.) or data analysis tools (e.g., Excel, PowerBI, etc.) to model or collect the data to comply with the system requirements.

        - Integrate the data and reporting tools to provide real-time visibility into KPIs.
        - Integrate the tools within the departments to have a “one-stop” platform for all things related to the business unit. Therefore, it is not scattered digitally.
        - Configure, test, and adjust the system to ensure all processes and flow are correctly implemented as designed.
    - Deliverables: Updated infrastructure, Integrated tools pool and systems, system integration reports, and new or updated tools.
4. Process Standardization and Documentation (Month 1-6, Parallel):
    - Objective: Develop, create, and test standardized work documents and processes.
    - Activities:
        - Create detailed work instructions for all processes, ensuring it is easy to follow and implement, especially for new employees in onboarding or training.
        - Record the duration and effectiveness of improvement data.
        - Develop a comprehensive guidebook that includes all documentation within a department (e.g., Production, Distribution, Demand, Raw material procurement, etc.), such as step-by-step instructions, KPI measurement locations, process workflow, troubleshooting guidelines, emergency situation checklist, etc.
        - Test and train employees about the process and work instructions.
    - Deliverables: Standardized Work Instructions Manual, Onboarding materials.
5. Pilot Testing, Evaluation, and Revision (Month 7-11):
    - Objective: Test the integrated design in a controlled environment to identify and solve early design issues.
    - Activities:
        - Implement the design in a test environment within a specific test case.
        - Monitor performance, efficiency, and effectiveness of the design.
        - Gather feedback from stakeholders.
        - Make necessary adjustments to the process or tools.
    - Deliverables: Pilot test report, list of identified issues, action plan for improvement and adjustments, robust tools according to project design.
6. Go-Live (Month 11-12):
    - Objective: The grand design is published for all relevant stakeholders to use as a basis for their work.
    - Activities:
        - Gradually expand the level of details or coverage of the scope to unrealized process in the initial project design and planning.
        - Create awareness and marketing of the integrated grand design.
        - Continue to monitor and collect feedback intensively for the first few weeks of implementation.

        - Ensure all employees are trained, aware, and comfortable with the new product.
    - Deliverables: Fully implemented integrated supply chain grand design.
7. Continuous Monitoring (Month 12 and onwards):
    - Objective: Monitor performance and continue optimizing the processes based on the design.
    - Activities:
        - Conduct scheduled reviews of the KPI performance.
        - Regular quarterly meetings discuss past performance, current situation, and future targets.
        - Establish an open-minded feedback loop to encourage employees to suggest improvements and ideas when the evaluation and updating schedule is reached.
        - Stay current with industry technology and processes to remain relevant within the business unit.
    - Deliverables: Performance review reports and continuous improvement initiatives.

For the system engineering implementation part (system requirement and design), it is recommended to collect all the requirements as effectively as possible initially. The deliverables focus more on business unit strategy with general planning per department or function. They need to be shared with the team members in the business unit or grand design scope.

This solution must be a top-down approach; an order or authority comes from a superior or upper-level management; otherwise, relying on initiative will be challenging because of the current workload this project will give. The system engineering requirement in the overview will need to include:

1. Define the specific business unit or similar.
2. Define the departments in the business unit or similar.
3. Define the functions (e.g., Production Planning, Distribution Planning, Material Planning, Demand Planning).
4. Define the activities conducted per the job description of the functions and departments.
5. Define the resources needed in each activity (E.g., Work documents, service level agreement documents, etc.).
6. Define the success parameters or performance indicators (PIs) for each department activity, such as backorder value, out-of-stock, OTIF, Lead time, etc.
7. Define the formula or variables that made the KPIs and define the KPIs definitions or guidelines. Also, define the location of where the data/information can be obtained. For example:
   Lead time = Order Delivered – Order Placement.
   Outbound logistics data provide the order delivery date. The system's order entry provides the order placement.

8. Create the overall value map to map all activities. The value map is easier to understand because it is not technical. However, a more technical process map should also be available as a derivative of the value map.
9. Analyze the currently available processes.
10. Missing processes will need to be prioritized. If the process is already there, it can be optimized. If it is not mapped yet, it needs to be created.
11. See which variables can be obtained from which process/activity in the process map.
12. Create an integrated flow process map, guidelines, and documentation
13. Create a system/platform that can be updated comprehensively. Automating the system as much as possible, especially numerous input activities to reduce human interaction, can lead to human error:
    1. Process that is agreed upon by all stakeholders.
    2. Create a data collection method (e.g., scanning barcodes, sensors, routines, etc.) and utilize existing tools to record all existing information or data based on needs and in real time.
    3. The process map has measurements that can be analyzed quantitatively.
14. After knowing the performance of each activity from the overall flow and comparing it with the benchmark (define benchmark: best practice, industry standard, company ambition).
15. Schedule reviewing of the process.

Based on Christopher (2011) shown in Figure 39, the goal is to transform the supply chain and way of working from stage two (functional integration) to stage three (internal integration) (Christopher, 2011). Therefore, to have an integrated collaboration of the departments, especially on the information sharing and coordination.

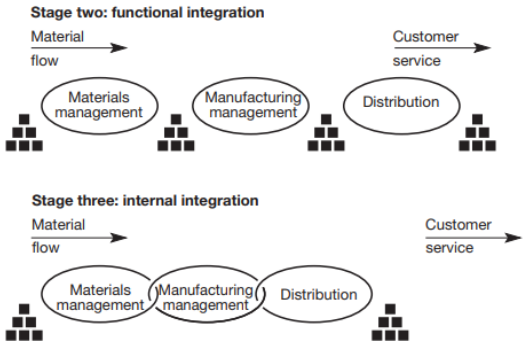

Figure 39 Transformation from Functional Integration (Stage 2) to Internal Integration (Stage 3) (Christopher, 2011)

4. **Long-term** (>12 months)
    1. Continuous Improvement Culture (Team up to Organizational Level)
       The most challenging part of the solution is the continuous improvement culture. The implementation, for now, is about influence from one individual to another because changing culture externally would be costly and unsustainable in the long run. However, culture itself is a habit formed by a group of individuals who follow the same

routines. The company can create a routine that leads to a continuous improvement goal. The best moment to start is now.

6.5 Validation of the Findings

To ensure the reliability of the findings, a validation session was conducted with the relevant stakeholders, referred to as "participants," comprising members of the team overseeing the regional market project. The session covered three (3) main agendas: presenting the research findings, a question-and-answer (Q&A) session, and collecting validation feedback. The validation process involved presenting five validation questions designed to assess whether the research findings and proposed solutions were considered feasible for implementation and to determine their potential impact on enhancing the lead time performance of the order-to-delivery process. The validation questions (VQ) included:

1. VQ1: What do you think about the research findings?
2. VQ2: Do you agree with the condition and solution presented?
3. VQ3: Do you think the proposed solution can help improve the lead time of the order-to-delivery process in the future (directly or indirectly)?
4. VQ4: Do you think that these suggestions are implementable?
5. VQ5: Are there more future actions or research efforts to be done to help implement these solutions beyond the current research findings

The first validation question (VQ1) was addressed during an open **Q&A session**, where participants shared their perspectives and raised questions about the findings. Key interactions included:

1. Q1: "*How can we manage operational tasks when workloads are already high, only leaving little time for improvement efforts?"*
    a. **Author's Response**: For example, the operational and improvement tasks should be integrated within a standard 40-hour workload, with a portion of time (e.g., 8 hours) allocated for improvements. The remaining hours would be dedicated to operational tasks, which must be completed more efficiently or redistributed among the team. The balance depends on the workload and the employees' capabilities, as improvement efforts are essential parts of operations.
    b. **Participant's Agreement:** The questioner and the participants agree on this answer. Further study on workload management may be conducted within the team. One participant suggested continuous improvement should be embedded within operational tasks to avoid separate task lists.
2. Q2: "*How can we ensure data accuracy, considering that using the DMAIC framework with incorrect data could lead to incorrect solutions?*"
    a. **Author's Response**: Ensuring data accuracy is critical at every stage, with a focus on system robustness and consistency. A measurement and data verification standard should be defined, agreed upon, and evaluated regularly to minimize errors, even if complete accuracy cannot be guaranteed. A proper data collection and usage process should be maintained to achieve reliable results.
    b. **Participants' Agreement**: This answer was well received, with participants emphasizing the importance of methodological rigor.

3. Q3: "*What are the factors that influence a shift between Make-to-Order (MTO) and Make-to-Stock (MTS) planning strategies or vice versa?*"
    a. **Author's Response**: The shift depends on order frequency, trigger characteristics, production lead time, product consumption patterns, and shelf life.
4. Q4: "*Does production lead time only involve the time for producing the product, or does it include raw material procurement and other activities?*"
    a. **Author's Response**: Production lead time can include raw material procurement and related activities, as defined in this project as the period from order entry to material availability.
    b. **Participant's Input**: One participant suggested naming it "Make" lead time for clarity, highlighting that production lead time is part of the broader "Make" phase. This prompted further discussion on defining lead times more precisely
    c. **Note**: "Make" lead time is out of scope; what is emphasized here is high lead time when producing the products. It can be influenced by raw material procurement or other activities; this should be defined further, especially the more detailed activities between the defined order entry date and material availability date. The team notes further discussion, which will be discussed further.
5. Q5: "*Following up to Q4, is there a way to measure production lead time?*"
    a. **Participant's Response**: A participant noted that work was already underway to measure production lead time, revealing that this aspect had not been fully documented previously

The Q&A session fostered a constructive and open dialogue, with new insights shared among participants. The findings were positively received, and further discussions were planned for internal follow-up actions.

The second validation question (VQ2) is, "*Do you agree on the condition and solution presented?"*. All participants anonymously agreed with the condition and solution presented, validating that the research accurately reflected current company practices and proposed practical solutions.

The third validation question (VQ3) is, "*Do you think the proposed solution can help improve the lead time of the order-to-delivery process in the future (directly or indirectly)?"*. All participants anonymously agreed that the solutions could positively impact lead time, particularly in an indirect capacity. One participant emphasized that the proposed solution serves as an initial step toward collecting necessary data before identifying the direct causes of lead time issues.

The fourth validation question (VQ4) is, "*Do you think that these suggestions are implementable?"*. The participants agreed, but with some additional notes to the answer, they noted additional elements that would enhance the process, such as involving other functional teams, gathering more data, and prioritizing the project due to its complexity. These elements were already considered in the research's proposed solutions, including the integrated supply chain design and end-to-end process mapping.

Finally, the fifth validation question (VQ5) is, "*Are there more future actions or research efforts to be done to help implement these solutions beyond the current research findings?*" The participants agreed with the previous discussion. One participant reiterated the importance of maintaining data accuracy and continuous verification as a foundation for effective decision-making and process improvement.

Post-Validation Discussion

The session concluded with an open discussion led by one of the participants, who asked the other participants for input on the next steps following the research findings. Suggestions included adding production planners to the team, further detailing the “Make” process, mapping the necessary steps, and beginning consistent data measurement. Moreover, the same participant appreciated the research, noting its role in raising awareness within the team and fostering a data-driven approach to continuous improvement.

This validation session confirmed the feasibility and potential impact of the proposed strategies, underscoring the need for integrated efforts and ongoing data accuracy to drive improvements in the order-to-delivery process.

6.6 Sub-Conclusion of Chapter 6

Chapter 6 outlines potential improvement solutions for the issues identified in Chapter 5, evaluates their feasibility, proposes actionable strategies, details the implementation plan, and validates the findings with company representatives.

Based on the analysis in Chapter 5, the proposed solutions include creating an integrated supply chain grand design, developing an end-to-end process map and measurement system, standardizing work documents, reporting methods, and communication, fostering a continuous improvement culture, and implementing scheduled reviews and tool improvements. These solutions address the lack of urgency in initiating improvements, manual data entry, fragmented departmental communication, unaligned workflows and documentation, limited activity measurement, unclear roles, and a need for a culture of continuous improvement.

The feasibility of these solutions is evaluated using SWOT and cost-benefit analyses to understand company capabilities and potential benefits relative to costs. Immediate recommended actions focus on standardizing work documents, reporting methods, and communication; implementing scheduled reviews, awareness, and improvement of tools; and developing an end-to-end process map and measurement. Solutions requiring more extensive planning, such as the integrated supply chain grand design and fostering a continuous improvement culture, are recommended for phased implementation due to their complexity and organizational challenges beyond this project's scope.

The implementation plan includes detailed preliminary actions categorized into immediate (under 1 month), short-term (1–3 months), medium-term (6–12 months), and long-term (more than 12 months) steps, with practical details on system requirements.

Finally, the chapter validates these findings by presenting them to the company’s representatives, who agreed with the proposed solutions' potential to improve lead time performance. However, further internal assessments are necessary to address implementation constraints not covered by this study.

In summary, Chapter 6 successfully proposed improvement solutions, outlined actionable strategies, and secured company approval that these recommendations could enhance the lead time performance of the order-to-delivery process.

7 Conclusion and Recommendations

7.1 Conclusion

The analysis and discussions presented in this study effectively address the research questions set forth at the beginning. The main research question, "*How can the order-to-delivery process performance in the targeted regional market be improved?*" is answered by recommending a more systematic, structured, and data-driven approach. This involves integrating and measuring processes specific to the department's operations in the regional market. Five sub-research questions (SRQs) have explored the main research question.

The first sub-research question (SRQ1), "*What is the company's relative position based on the conducted background study?*" examines the company's competitive position in relation to the theoretical framework from the background study. Findings show that the company maintains a strong value advantage but continues efforts to improve cost-competitiveness, mainly through enhancing supply chain efficiency and reducing expenses. These insights align with the company's strategic objectives and underscore the importance of improving lead time performance to support cost-effectiveness.

The second sub-research question (SRQ2), "*What is the current process performance of the targeted regional market?*" was investigated through data collection on the existing situation. The study found that limited measurements required to assess an order-to-delivery process are currently in place, processes are unmapped and undocumented, and the necessary documents are often not based on sound data or evidence. Additionally, improvement gaps in the system integration, analysis tools, and interdepartmental communication and knowledge have led to inefficient, siloed operations. These findings emphasize the need for comprehensive process mapping and documentation.

The third sub-research question (SRQ3), "*What are the root causes of the current lead time performance in the order-to-delivery process, and what are the directions for achieving the improvements?*", identified that lead time inefficiencies stem from systemic issues. Root causes include the absence of structured performance measurements, lack of standardized processes, and insufficient focus on customer-centric practices and continuous improvement. Addressing these challenges requires enhanced data collection and better system integration to facilitate further process improvements and root cause resolution.

The fourth sub-research question (SRQ4), "*What are the actionable strategies for implementing the potential solutions in the supply chain, and how can the company measure the success of the implementation concerning the lead time?*" suggests that the recommended direction for improvement is to create a standardized, measured, and integrated system, guided by an end-to-end process map. This approach ensures that relevant data points are identified and monitored. An overarching supply chain grand design should be developed as a strategic blueprint to align processes and goals. Regular and scheduled reviews and updates of processes and performance metrics are essential, supported by structured assessments to ensure and monitor ongoing performance effectiveness. Implementation should be systematic and collaborative, involving standardized documentation, clear reporting, and consistent communication across all

organizational levels. Leadership must provide direction through strategic plans, fostering an environment that supports continuous improvement and sustained performance enhancement.

The fifth sub-research question (SRQ5), "*How do the company representatives accept and find the proposed improvements for the order-to-delivery process implementable and impactful, and what feedback can they provide for further refinement?"* was addressed through validation sessions with company representatives. These discussions confirmed the feasibility and potential impact of the suggested improvements. Feedback from the sessions indicated a positive reception, with plans for internal follow-up discussions on implementation strategies.

In conclusion, achieving consistent, data-driven lead time performance requires establishing standardized processes and robust measurement systems. This enables more effective identification and resolution of root causes, supporting continuous evaluation and improvement led by a team committed to a culture of long-term performance enhancement.

7.2 Recommendations

There are several key aspects to focus on to improve lead time in the process. The key recommendations include:

1. A blueprint of how everything works can provide a clear overview of the situation's directions, targets, roles, and responsibilities. The integrated supply chain grand design can accommodate this.
2. Start mapping the end-to-end processes, collecting data, measuring the activities, and aligning this information with stakeholders to identify and address gaps in existing processes or measurements with a data-driven approach to decision-making.
3. Standardize, organize, and optimize existing processes, documents, reports, and communication for a well-structured, efficient, effective, and clear way of working.
4. Foster a continuous improvement mindset and customer-centric approach for better work purposes and optimal results.
5. Periodically evaluate tools and processes on a schedule to identify and minimize defects beforehand.

7.3 Further Research

1. **Costing of Implementation Plan**
   The cost of the implementation plan is needed in further research to know the estimated monetary cost and benefits if the solution is implemented. From the current research findings, the cost-benefit analysis only discusses the perceived cost and benefits of the current improvement solutions. This also considers that if the solution implementation is done partially, it might impact the expected benefit. A more comprehensive costing method is needed to utilize the full potential of cost-benefit analysis in a monetary approach.
2. **Impact and Performance Analysis of the Improvement Implementation**
   Impact and performance analysis of the improvement implementation is a continuation of the current research findings, where the solution has been implemented and more data is available for further analysis. A data-driven approach can analyze the impact and performance of the order-to-delivery process, which is a prerequisite to future improvement of the process.

3. **Implementation of Change Management for Continuous Improvement Culture**
   This research seeks continuous improvement culture as the most challenging improvement solution. Literature suggests that change management is the approach to promoting a continuous improvement culture. Further assessment on implementing a continuous improvement culture within the organization with change management is believed to bring high benefit as the company may transform into a learning organization and possess superior initiative in continuous improvement through its new culture.

References

Adonyi, R., Biros, G., Holczinger, T., & Friedler, F. (2008). Effective scheduling of a large-scale paint production system. *Journal of Cleaner Production, 16*, 225-232.

Aliche, K., Rachor, J., & Seyfert, A. (2016, October 27). *Supply Chain 4.0 – the next-generation digital supply chain*. Retrieved May 30, 2024, from McKinsey & Company: https://www.mckinsey.com/capabilities/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain#/

American Coatings Association. (2021, June). *The Paint and Coatings Industry: An Essential Contributor to Rebuilding the U.S. Economy and Infrastructure.* Retrieved from American Coatings Association: https://www.paint.org/wp-content/uploads/dlm_uploads/2021/05/ACA-IssueBackgrounder-JUNE2021.pdf

Bain & Company, Inc. (2021). *Global Energy and Natural Resources Report 2021: Navigating the Energy Transition.* Bain & Company, Inc.

Beier, J., Konzok, T., Saunders, M., Kaplin, C., Maue, A., & Guse, C. (2024, August 7). *A New Approach to Cost—and Growth—in Process Industries*. Retrieved from Boston Consulting Group: https://www.bcg.com/publications/2024/new-approach-to-cost-and-growth-in-process-companies?utm_source=instagram&utm_medium=social&utm_campaign=cost&utm_description=organic&utm_topic=cost&utm_geo=global&linkId=569981317

Christopher, M. (2011). *Logistics & Supply Chain Management* (4th ed.). Harlow: Pearson Education Limited.

Coccia, M. (2017). The Fishbone diagram to identify, systematize and analyze the sources of general purpose technologies. *Journal of Social and Administrative Sciences, 4*, 291-303.

Davenport, T. H., & Redman, T. C. (2020, May 21). *Digital Transformation Comes Down to Talent in 4 Key Areas*. Retrieved from Harvard Business Review: https://hbr.org/2020/05/digital-transformation-comes-down-to-talent-in-4-key-areas

de Castro, A. V. (2021). *Raw material shortages in the coatings industry: Challenges and implications for the sector.* Retrieved from CEPE: https://fargprodukter.se/wp-content/uploads/Article-While-the-pandemic-continues-raw-materials-are-running-short-in-the-coatings-industry-1.pdf

de Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of. *International Journal of Production Economics, 139*, 604-614.

Dorfhuber, C., O'Leary, J., & Agarwal, S. (2020, September 9). *Surviving the pandemic budget shortfalls*. Retrieved from Deloitte Insights: https://www2.deloitte.com/us/en/insights/economy/covid-19/state-budget-shortfalls.html

Elliott, V. (2018). Thinking about the Coding Process in Qualitative Data Analysis. *The Qualitative Report, 23*(11), 2850-2861.

Fortune Business Insights. (2024, August 5). *Paints and Coatngs Market Size, Share & Industry Analysis, By Resin, By Product Type, By Application, and Regional Forecast, 2024-2032*. Retrieved from Fortune Business Insights: https://www.fortunebusinessinsights.com/industry-reports/paints-and-coatings-market-101947

Gamberini, L., Imbriaco, G., Ingrassia, P. L., Mazzoli, C. A., Badiali, S., Colombo, D., . . . Corte, F. D. (2022). Logistic Red Flags in Mass-Casualty Incidents and Disasters: A Problem-Based Approach. *Prehospital and Disaster Medicine, 37*(2), 197-204.

George, M. L. (2003). *Lean Six Sigma for Service.* The McGraw-Hill Companies, Inc.

Guarraia, P., & Zech, S. (2021, June 22). *Creating Resilience, Sustainability, and Accountability in Supply Chains*. Retrieved from Bain & Company: https://www.bain.com/insights/creating-resilience-sustainability-accountability-in-supply-chains-enr-report-2021/

Harrison, A., & van Hoek, R. (2011). *Logistics Management and Strategy: Competing Through the Supply Chain* (4th ed.). Essex: Pearson Education Limited.

Helms, M. M., & Nixon, J. (2010). Exploring SWOT analysis - where are we now?: A review of academic research from the last decade. *Journal of Strategy and Management, 3*(3), 215-251.

Iacoviello, A., Whiteford, E., & Downie, A. (2024, July 4). *What is change management?* Retrieved from IBM: https://www.ibm.com/topics/change-management

International Organization for Standardization. (2015). *Quality management systems - Requirements.* International Organization for Standardization. Retrieved from https://www.iso.org/standard/62085.html

Jacquemijns, J. (2017). *Process improvement to shorten the.* Aplhen aan den Rijn: Delft University of Technology.

Kenton, W. (2023, December 18). *Lean Six Sigma: Definition, Principles, and Benefits*. Retrieved from Investopedia: https://www.investopedia.com/terms/l/lean-six-sigma.asp#:~:text=Investopedia%20%2F%20Daniel%20Fishel-,What%20Is%20Lean%20Six%20Sigma%3F,lean%20manufacturing%2Flean%20enterprise%20philosophy.

Kenton, W. (2024, February 28). *Lead Time: Definition, How It Works, and Example*. Retrieved from Investopedia: https://www.investopedia.com/terms/l/leadtime.asp

Kettinger, W. J., & Grover, V. (1995). Special Section: Toward a Theory of Business Process Change Management. *Journal of Management Information Systems, 12*(1), 9-30. doi:10.1080/07421222.1995.11518068

Kim, W., & Mauborgne, R. (2005). *Blue Ocean Strategy.* Boston: Harvard Business School Press.

Knowles, G., Whicker, L., Femat, J. H., & Canales, F. D. (2005, March). A conceptual model for the application of Six Sigma methodologies to supply chain improvement. *International Journal of Logistics: Research and Applications, 8*(1), 51-65.

Kotler, P., & Keller, K. L. (2016). *Marketing Management* (15th ed.). Essex: Pearson Education Limited.

Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer.* Madison: McGraw-Hill.

Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: a synthesis guiding the novice. *Qualitative Research Journal, 19*(3), 259-270.

Mahto, D., & Kumar, A. (2008). Application of root cause analysis in improvement of product quality and productivity. *Journal of Industrial Engineering and Management*, 16-53.

Mintzberg, H., & van der Heyden, L. (1999, September). Organigraphs: Drawing how companies really work. *Harvard Business Review, 77*, 87-94.

Miranda, D., Bottorff, C., & Watts, R. (2022, August 7). *The Four Principles Of Change Management*. Retrieved from Forbes Advisor: https://www.forbes.com/advisor/business/principles-of-change-management/

Montier, J. (2009). *Value Investing: Tools and Techniques for Intelligent Investment.* West Sussex: John Wiley & Sons Ltd.

Oberholzer-Gee, F. (2021, May-June). *Eliminate Strategic Overload*. Retrieved from Harvard Business Review: https://hbr.org/2021/05/eliminate-strategic-overload

Orcun, S., Discioglu, A., Altinel, I., & Hortacsu, O. (1997). Scheduling Of Batch Processes: An Industrial Application In Paint Industry. *Computers and Chemical Engineering, 21*, 673-678.

Perreault, W. D., & McCarthy, E. J. (2002). *Basic Marketing: A Global-Managerial Approach* (Vol. 14th). New York: McGraw-Hill/Irwin.

Pettersson, A. I., & Segerstedt, A. (2013). Measuring supply chain cost. *International Journal of Production Economics*(143), 357-363.

Pilcher, G. R. (2021, April). *Paint and Coatings Raw Materials in 2021: It's All About Resilience*. Retrieved from American Coatngs Association: https://www.coatingstech-digital.org/coatingstech/april_2021/MobilePagedArticle.action?articleId=1673584&app=false#articleId1673584

Polymer Paint Colour Journal. (2024, March 19). *Polymer Paint Colour Journal*. Retrieved from The evolution and dynamics of the paints and coatings market: https://www.polymerspaintcolourjournal.com/the-evolution-and-dynamics-of-the-paints-and-coatings-market/

Porozantzidou, S. (2015). *Improving the Outbound Logistics Process at KLM Engineering & Maintenance.* Delft University of Technology, Faculty of Technology, Policy and Management. Delft: Delft University of Technology.

Porter, M. E. (1998). *Competitive Advantage: Creating and Sustaining Superior Performance.* New York: The Free Press.

Senge, P. M. (2006). *The Fifth Discipline: The Art & Practice of the Learning Organization*. Doubleday.

Sikharulidze, M., & Fuschi, D. L. (2023). Causes of Paints and Coatings Raw Materials Supply Chain Crisis and its Impact on Businesses. *Journal of Organisational Studies and Innovation, 10*.

Siwiec, D., & Pacana, A. (2021). Method of Improve the Level of Product Quality. *Production Engineering Archives, 27*(1), 1-7.

Soković, M., Pavletić, D., & Kern-Pipan, K. (2010). Quality improvement methodologies - PDCA cycle, RADAR matrix, DMAIC and DFSS. *Journal of achievements in the materials and manufacturing engineering*, 476-483.

Statista Research Department. (2024, April 2). *Leading paints and coatings companies worldwide in 2023, based on revenue*. Retrieved from Statista: https://www.statista.com/statistics/543989/leading-paint-companies-worldwide-by-revenue/#:~:text=Based%20on%20revenue%2C%20the%20United,dollars%20of%20revenue%20that%20year.

Statista Research Department. (2024, July 11). *Market share of coatings and paints companies worldwide in 2022*. Retrieved from Statista: https://www.statista.com/statistics/725921/paints-and-coatings-global-market-share-by-company/

Štěrbová, M., Loučanová, E., Paluš, H., Ivan, Ľ., & Šálka, J. (2016). Innovation Strategy in Slovak Forest Contractor Firms - A SWOT Analysis. *Forest, 7*.

Stevens, G. C. (1989). Integrating the Supply Chain. *International Journal of Physical Distribution & Logistics Management, 19*(8), 3-8.

Talib, M., Hamid, A., & Thoo, A. (2015). Critical Success Factors of Supply Cain Management: A Literature Survey and Pareto Analysis. *Euromed Journal of Business, 10*(2), 234-263.

Weiss, K. D. (1997). Paint and coatings: A mature industry in transition. *Progress in Polymer Science, 22*, 203-245. doi:doi:10.1016/s0079-6700(96)00019-6

Yu, H. (2024). *How supply chain inefficiencies are stealing your profits*. Retrieved from AT&T Business: https://www.business.att.com/learn/articles/how-supply-chain-inefficiencies-are-stealing-your-profits.html#