Master's Thesis

Supply Chain Management: Increasing Performance and Coordination in a Sales & Operations Planning Context

A case study at Alfa Laval

THEODOR JENER

JACOB KNUTSSON

LUND UNIVERSITY

Department of Mechanical Engineering Sciences

Division of Engineering Logistics

Lund University, Faculty of Engineering

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Author	Jacob Knutsson
Author	Theodor Jener
Supervisor	Hanna Ånell
	PHE Global Supply Planner
	Alfa Laval
Supervisor	Louise Bildsten
	Senior Lecturer at the Division of Engineering Logistics and Programme Director of Logistics and Supply Chain Management (M.Sc.)
Examinator	Jan Olhager
	Professor at the Division of Engineering Logistics

Master's Thesis
Department of Mechanical Engineering
Division of Engineering Logistics
Lund University, Faculty of Engineering
SE-223 63 LUND
+46 222 72 00

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Abstract

Title	Supply Chain Management: Increasing Performance and Coordination in a Sales & Operations Planning Context
Authors	Theodor Jener and Jacob Knutsson
Supervisor	Louise Bildsten, Senior Lecturer at the Division of Engineering Logistics and Programme Director of Logistics and Supply Chain Management (M.Sc.)
Contribution	This thesis has been a complete elaboration between the two authors. Each author has been involved in every part of the process and contributed equally.
Problem description	Alfa Laval's business unit Gasketed Plate Heat Exchanger uses Sales and Operations Planning to balance supply with demand to ensure profitable growth. Currently, the business unit is experiencing inefficiencies as they fail to execute the plans from Sales and Operations Planning. Large inventories, high obsolescence, material availability, and "firefighting" are some problems mentioned. To support their strategy, the Sales and Operations Planning team wants to understand how they can address these inefficiencies and improve performance.
Purpose	The purpose of this thesis is to increase total coordination, performance, and strategic alignment of the S&OP process and its integral functions at Alfa Laval GPHE.
Research objectives	***RQ1:*** *How can integral business functions of S&OP impact supply chain performance?* ***RQ2:*** *What can be the cause of gaps between GPHE's S&OP plan and outcome?* ***RQ3:*** *What can the integral business functions of GPHE's S&OP do to be better aligned with strategic targets?*
Methodology	The methodology chosen to address this purpose is an inductive single case study with the Gasketed Plate Heat Exchange business unit as the unit of analysis. Qualitative information was gathered from the literature and empirical data from interviews. The methodology follows the structure of the research onion which fortifies the credibility of the study.
Conclusion	The findings of this thesis were that a lack of knowledge and awareness impacts the business unit to not adhere to plans from the Sales and Operations Planning and that supply chain discontents have led to a large assortment and low inventory turnover. To raise the plan adherence ability in the business unit it is recommended that a knowledge development initiative is driven. Such an initiative should include increasing managerial and process knowledge and spreading general awareness of the process. The inventory turnover rate can be improved by driving modularization and incentivizing an alignment between functions to enable a phase-out of old products and indirectly obsolete inventory.
Keywords	S&OP, Strategy, Inventory, Operations, Strategic alignment

Definitions and abbreviations

GPHE – Gasketed Plate Heat Exchanger, a business unit at Alfa Laval.

GCC – Global Core Components, a type of factory at Alfa Laval.

LA – Local Assembly, a type of factory at Alfa Laval

Business unit – An entity in an organization that is responsible for certain products and operations.

Business function – A function within the business unit with the responsibility of a certain process, e.g., sales, product management.

Inventory levels – The amount of inventory available throughout a supply chain or at certain parts of the supply chain.

Lead time – The time it takes from the start of a process until it is finished and has served its purpose.

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1 Introduction

This chapter aims to provide background about supply chain management, strategy, S&OP, and the challenges of inter-functional coordination. Furthermore, the specific case at Alfa Laval GPHE and its problems are also presented. Lastly, the chapter outlines what the thesis tries to resolve by stating the purpose of the thesis, its research questions, focus, and delimitations.

1.1 Background

The concept of supply chain management emerged from the field of logistics in the mid-1980s (Cooper, et al., 1997). Supply chain management can be defined as "The systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole" (Mentzer, et al., 2001). Supply chain management is becoming increasingly important for companies due to the inherent complexity and risks that follow in today's global business environment. Furthermore, supply chain management is also used to create a competitive advantage by increasing profitability and value to customers (Mentzer, 2004). To achieve this today, companies must increase their delivery accuracy while also shortening lead times. Simultaneously, efficiency throughout processes must be high and costs minimized (Mattsson & Jonsson, 2003).

In pursuit of competitive advantage companies can find themselves being constrained when trying to achieve multiple objectives that are counteractive. Treacy and Wiersma (1995) argue that companies cannot achieve success when trying to be all things at once. To gain a competitive edge, companies must define what not to do, thereby accepting trade-offs (Porter, 1996). Accepting trade-offs is not only important in a business strategy but also when forming a supply chain strategy. Supply chain strategy is a broad term that describes how a company chooses to value different actors and processes in their supply chain, what they should prioritize, and to what extent. Essentially, it describes how a manufacturing company decides to manage its supply chain; balancing satisfactory inventory levels, while also trying to remain lean and agile in its operations, and with high customer satisfaction (Zahedi, et al., 2020). DeSmet (2021), argues that the essence of supply chain management is finding a strategy in which the company balances three "pillars" of supply chain management, namely *service*, *cost*, and *cash*. The three categories can be used to form a triangle which in turn captures how companies can deliver different levels of service at a cost with the help of cash (DeSmet, 2021).

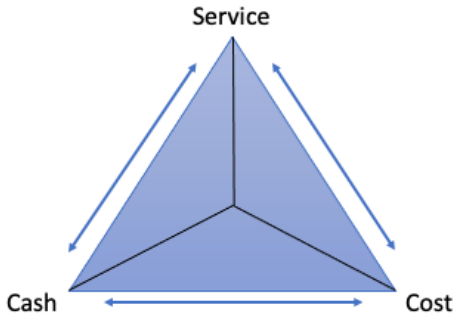

Figure 1.1 The supply chain triangle. Source: (DeSmet, 2021).

In an effort to define and explain supply chain management, Mentzer, et al. (2001) highlights the importance of inter-functional coordination. The authors claim that one of the characteristics of supply chain management is to synchronize efforts and capabilities of traditional business functions like sales, production, and purchasing, considering them all simultaneously. Inter-functional coordination can be exemplified through the topic of inventory. In short, the reason for having inventory is due to the mismatch of supply and demand that can take place at any given time (Chopra & Meindl, 2013). Especially manufacturing companies tend to have much capital tied up in inventory (Shah & Mittal, 2020). Different actors in the same organization can have contradictory goals which increase the complexity of the question of inventory. A sales manager would prefer high stock levels to be able to meet customer orders, while a production manager would prefer low stock levels to free up cash for other operations. On the other hand, a purchasing manager usually wants large order

batches to minimize purchasing costs. As neither function can be decoupled from another in an organization, dealing with these requests is imperative (Axsäter, 2006).

The managers' contradictive goals mentioned above are one kind of dilemma that can occur at a manufacturing firm. Sales and operations planning (S&OP) is a tool that aims to unite separate business functions' plan into one integrated set of plans. The goal of S&OP is to balance supply and demand but also to connect the strategic plan of a firm with its operations plan (Tavares, et al., 2012). Although it varies between companies, S&OP typically consists of a five-step process (ibid). Representatives from various functions at a company meet, develop, and agree on a consensus-operations plan that is implemented for a horizon of 1-18 months. This could be functions such as sales, operations, inventory, and finance. Furthermore, the process also includes measuring and evaluating the process. By doing all this, a company can balance its supply and demand (Grimson & Pyke, 2007).

To conclude, much research has been conducted on the topics of supply chain management and strategy. There are many aspects to consider when allocating resources to a supply chain and prioritizing objectives. In a supply chain strategy, it is important to coordinate individual efforts, so that they are aligned as one. S&OP is a process that takes many functions into consideration and tries to steer and balance demand and supply. This thesis takes a holistic approach and examines how functions with an integral part of S&OP can affect supply chain performance. Furthermore, this thesis investigates the specific case of the GPHE business unit at Alfa Laval and how they can coordinate functions to align better with strategic goals.

1.2 Problem formulation

Alfa Laval is a market leader in the heat transfer, separation, and flow management industry. The company is divided into three divisions; food & water, energy, and marine which have a global presence and deliver services and products in over 100 countries. One of Alfa Laval's business units in the energy division is called Gasketed Plate Heat Exchange (GPHE). This business unit primarily focuses on developing and delivering customer tailored and energy efficient heat exchangers.

The Covid-19 pandemic have had many global effects, one of them being supply chain disruption. Material and delivery availability was low and lead times were high. Fortunately, Alfa Laval's GPHE business unit managed to get through this crisis as they had a large inventory which ensured production during these tough times. However, according to GPHE, this was considered a fortunate result. In the aftermath of the pandemic, GPHE finds itself in a scenario where they have issues with re-establishing supply chain performance and inventory levels in line with the strategic goals of the business unit. This concern evolved into a project which aimed to bridge the gap between strategic plans and supply chain management.

The GPHE business unit has adapted the S&OP process to drive cross-functional collaboration and decision-making to prepare its supply chain to meet future demand and enable profitable growth. In the S&OP, certain GPHE functions meet, provide inputs, discuss, and agree on a consensus plan that specifies what supply and capacity are needed to manufacture a certain amount of demanded products. However, once the plan is put into action, the expected result is not achieved. Large inventories, high obsolescence, material unavailability, and "firefighting" are some problems mentioned. This inability to execute from a supply chain perspective harms GPHE's ability to reach its strategic goals. To be able to support the overall strategy of the business unit, the S&OP team wants to understand how integral functions of S&OP are managed to be able to explain why the agreed-upon plans are not realized. In short, there is a gap between what is decided upon in the S&OP and what actions are taken that harms performance.

1.3 Purpose

The purpose of this thesis is to increase total coordination, performance, and strategic alignment of the S&OP process and its integral functions at Alfa Laval GPHE.

1.4 Research questions

As this thesis aims to investigate how functions in a supply chain can be managed in line with a strategy, it is imperative to understand how supply chain performance can be enhanced. Research question 1 (RQ1) is formulated to holistically examine, from a theoretical point of view, which the integral functions of the S&OP are and how they can be managed to have an impact on supply chain performance. The question is intended to be answered by studying and concluding relevant literature findings.

RQ1: How can integral business functions of S&OP impact supply chain performance?

Due to the current lack of understanding at GPHE of why plans decided upon are not realized in execution, research question 2 (RQ2) is formulated. The question looks to examine what the gaps are and what the underlying cause of the gaps could be. This will be analyzed by interviewing key people at GPHE regarding processes, collaboration, strategy, and decisions making. By doing so data will be gathered about how GPHE and certain functions are managed. Furthermore, patterns that can be linked to the gaps can be identified. With the findings from RQ1 in mind and the data collected from interviews, the cause of the gaps can be addressed through RQ2.

RQ2: What can be the cause of gaps between GPHE's S&OP plan and outcome?

With the knowledge gained from RQ1 and RQ2, an understanding of the impact that integral functions of the S&OP can have on supply chain performance and an analysis of the cause of gaps between the S&OP plan and execution has been established. The purpose of research question 3 (RQ3) is then to analyze how integral functions of the S&OP could be managed in a way that is more aligned with the strategic targets of the business unit. RQ3 will ultimately analyze how S&OP's gap between plan and execution can be bridged to align decisions with strategic targets.

RQ3: What can the integral business functions of GPHE's S&OP do to be better aligned with strategic targets?

1.5 Focus and delimitations

Before mentioning the focus and delimitations for this thesis, a short description of the GPHE main material flow and entities relevant to this thesis is necessary. Material is purchased from suppliers and then travels through two types of factories called Global Core Components (GCC) and Local Assembly (LA). In these factories, material is refined into components and assembled into final products. From the point at which the material starts to travel through the production until it leaves the factory, after having been stored, it is considered held inventory. This description is illustrated in Figure 1.2. GPHE's S&OP focuses on balancing the demand from the market with the supply and capacity that the factories, GCC and LA, need.

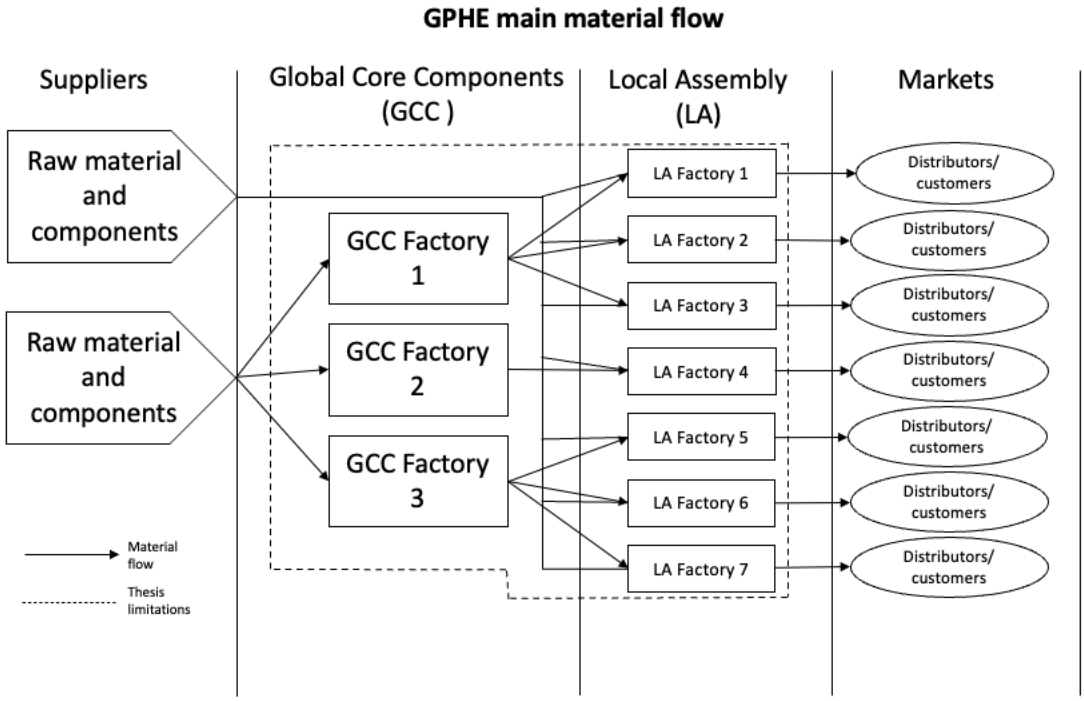

Figure 1.2. The scope and limitation of thesis. Created by authors.

The primary focus of this thesis is to evaluate how supply chain management can impact performance to understand the existing gap between GPHE's S&OP plan and execution. This will be done by focusing on S&OP and its integral functions to be able to address what these functions can do to align better with strategic goals. As a result, the scope of the thesis is steered to map and analyze how supply chain strategy can be used to enhance business performance, but also to practically apply this knowledge in a real-life scenario. Another aspect that will affect the focus of the thesis is that of the GPHE business unit at Alfa Laval. This influence will guide the thesis to focus on diagnosing the root cause of the case company's problem and providing realistic recommendations.

As this thesis includes supply chain management in general, but also supply chain strategy and how it links to inventory, operations, and various functional areas, many theories and fields of study will be touched upon. However, due to the 20-week time constraint on the thesis, the methodology and research will be limited regarding some research decisions.

This thesis only considers the Alfa Laval business unit GPHE and integral functions of S&OP which have a direct effect on the S&OP outcome and supply chain performance. In other words, sales, product management, sourcing, and operations are directly involved in product review, demand forecasting, and supply planning. As this thesis will analyze supply chain strategy on a high level, it will not consider detailed improvements like mathematical applications for process improvements. This thesis will not consider the aspect of implementing change in the best way possible for the setting. Furthermore, the thesis will not cover aspects of improving software or information systems that can be tools for businesses. The topic of operations will be limited to a focus on manufacturing, capacity, and inventory. Thereby excluding aspects like quality, safety, transportation, and more. Functions that are not directly integral to the S&OP like research and development, human resources, and others will also not be considered. The topic of purchasing and sourcing will be limited to focus on supplier selection based on cost, speed, and volume. This excludes aspects like risk, quality, availability, negotiation, etc., which can affect supply chain performance.

1.6 Outline

The following is an outline of what the chapters in the thesis will cover.

Chapter 1 – Introduction

This chapter aims to provide background about supply chain management, strategy, S&OP, and the challenges of inter-functional coordination. Furthermore, the specific case at Alfa Laval GPHE and its problems are also presented. Lastly, the chapter outlines what the thesis tries to resolve by stating the purpose of the thesis, its research questions, focus, and delimitations.

Chapter 2 – Methodology

The methodology chapter is meant to provide an extensive and elaborate explanation of how this case study research has been structured and performed. The chapter is mainly based on theory from Saunders' et al. (2012) methodology process "The Research Onion". Furthermore, it provides the reader with explanations of the different methods and concepts that have been employed and why they were selected.

Chapter 3 – Frame of reference

This chapter aims to build a theoretical foundation within relevant areas of supply chain management that will serve as a basis for the purpose of this thesis. The structure of the chapter follows a logical order that seeks to raise the reader's knowledge of how performance can be enhanced through supply chain management and the challenges that follow. The areas covered are: Supply chain management, S&OP, Operations management, supply chain strategy, and organizational collaboration. The chapter is also concluded with an analytical model that provides an overview of the following sections of the thesis.

Chapter 4 – Empirical data

The empirical chapter provides an understanding of the organizational structure of GPHE and its relevant functional processes. Furthermore, it describes how the processes relate and what the strategic goals for the business unit are. The chapter is based on interviews with employees at Alfa Laval GPHE.

Chapter 5 – Analysis and evaluation

The analysis chapter looks to combine the knowledge from the literature review with the empirical data to provide an analysis that is in line with the research questions and the scope of the thesis. The analysis is based on matching patterns recorded in the empirical data and evaluating how these affect the perspective of the research questions.

Chapter 6 - Conclusion

The last chapter aims to conclude the main findings of each research question. Furthermore, it discusses the academic contribution and limitations of the thesis. Finally, it also addresses future research that could contribute to and complement the discussed topics of the thesis.

2 Methodology

The following chapter aims to provide an explanation to the methodology used throughout this thesis. It presents the decisions that have led up to how this thesis has been written as well as how the research has been conducted. Furthermore, it means to provide a discussion and explanation to the choices that have been made.

There is much research on methods and combinations of methods to decide upon when starting a research project. The choice of methodology is essential as it can be regarded as the backbone of the research. It provides a general direction of what strategy is used, how data is collected, and how conclusions are drawn in the final analysis. A structured and well-developed methodology is a significant factor in how the results and recommendations are perceived by the public. It can also provide evidence that the results can be trusted and open for further research on the subject.

Saunders et. al. (2012), have developed a framework for how the methodology of research or study can be structured. They have named it "The research onion" and it is illustrated in Figure 2.1 below. It considers research philosophies, the approach, methodological choices, strategies, time horizons, and techniques and procedures. Furthermore, it provides an explanation of how they are used in the research. Every element is illustrated as one layer in the onion. The methodology has been adopted for this thesis as it provides a structured and easy-to-understand explanation of the method. The purpose of the following chapter is to present decisions that have been made and summarize certain terms of the chosen method.

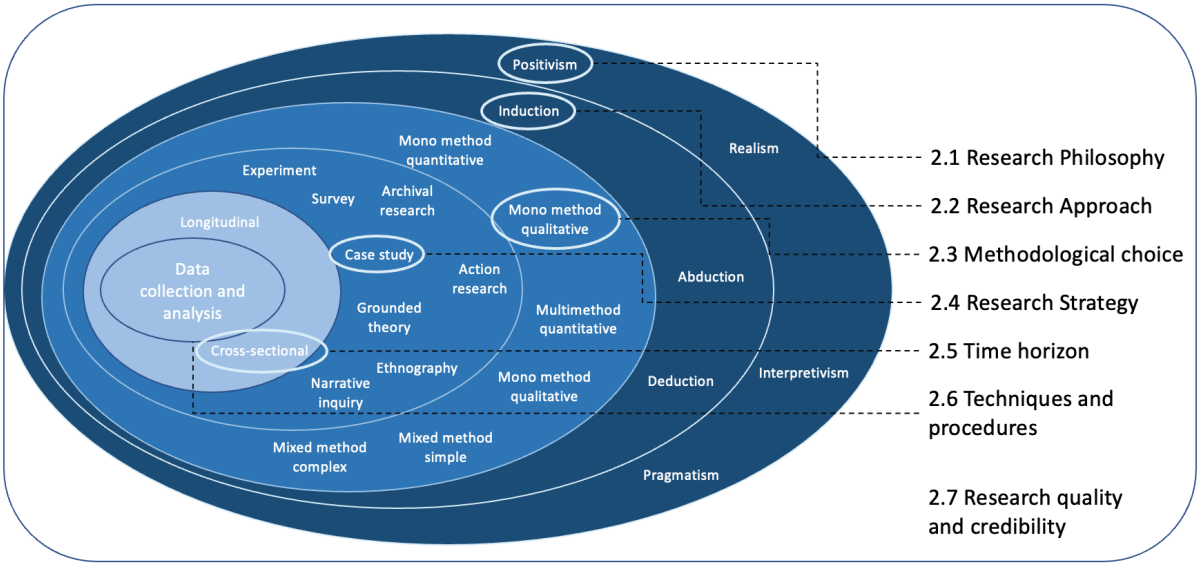

Figure 2.1. The research onion and selected path. Source: (Saunders, et al., 2012)

2.1 Research Philosophy

The nature of research is that it is often lined with the researcher's inferences. There is a risk that the phenomenon being studied is a matter of which people already have formed opinions, thus being biased before initiating the study (Kothari, 2004). No matter who or from what perspective research is conduced, it is inevitably clustered with assumptions, for example, what data is important or useful to examine. This outermost layer of the onion becomes imperative for the study as it in a way describes in what setting the research is performed and how the researcher sees and interprets the resulting data (Saunders, et al., 2012).

There are four major types of research philosophies, namely positivism, realism, interpretivism, and pragmatism (Saunders, et al., 2012). Each philosophy has its own perspective on the research approach, the role of the researcher, and the nature of reality.

Positivism has been selected as the philosophical perspective for this single case study. The philosophy has some key characteristics that are believed to be valuable for this type of study. It approaches

knowledge in a fashion that can be summarized as it tries to base observations and thinking in facts. It approaches knowledge and the development of said knowledge in an empirical manner, where everything should be based in evidence (Giddens & Sutton, 2021). In its core it states that knowledge can be obtained from that which is observable, measured and repeated, resulting in an increased validity and objectivity as it can reduce the influence of personal bias (ibid). These characteristics are highly useful for this research since the purpose of the study is to analyze and evaluate global entities in Alfa Laval GPHE and deliver results that are beneficial for the organization at large. Thus, the results must be both objective, general, and externally valid, to not only be applicable to the entity where the research is physically performed, and most empirical data is gathered.

2.2 Research approach

The research approach is the second layer of the research onion. It determines whether a study or research starts off with pre-formulated theories or a set of hypotheses and uses data collection to either build, validate, or discard them. Alternatively, the data collection of a study can be used as the starting point of the study, from where the theory or hypothesis formulation can take place. There is also a third option, which is a combination of the two that both builds, develops, and revises existing theories, while also confirming or denying the theories throughout the data collection (Saunders, et al., 2012). The extent to which the researcher has decided upon the research approach early in the work has a great impact on the rest of the design of the project.

The three different options are:

- **Induction** – A research approach is inductive when a phenomenon is explored, and theories can be generated through data collection, pattern detection, or the creation of frameworks. The collected data is then used to describe the phenomenon and finally, a conceptual theory is shaped from the data. The approach can be seen as a reverse funnel, where the researcher begins at the narrow end, with a specific idea, and broadens the knowledge development as the data collection progresses.
- **Deduction** – In contrast to induction, deductive research either confirms or is used to invalidate predetermined theories. It is characterized by emerging from rigid methodology, often deriving theories from literature reviews, then testing these theories in practice. The research becomes more and more specific after origin at a generalized starting point. Data collection is primarily used to substantiate hypotheses or prenotions related to existing theories.
- **Abduction** – Abductive research is moving back and forth between the two former approaches. It revolves around using data to generate and amend said theories, formulated before the research was initiated. It is both building new theories and hypotheses while also modifying them concurrently.

The research approach used in this report is inductive. It was decided since the aim of this thesis is to gather data and analyze current operations and events. Based on the information collected through interviews, conclusions will be formed on where measures can be targeted to better align the strategic decisions. As no propositions or hypotheses will be formulated, and thus cannot be tested, this rules out the option to choose both a deductive and abductive approach. Instead, the conclusions will then be matched with theories from the literature review. Thus, the funnel will be expanding from the narrow perspective obtained from employees at Alfa Laval GPHE to a more general and broader perspective that is found in literature. One benefit of the inductive approach is that the method is also increasing the external validity, see 2.7.3 External validity.

2.3 Methodological choice

The next layer in the research onion is choosing the methodology for the study or research. That is, choosing whether the project should be quantitative, qualitative, or a combination of the two. Saunders et al. (2012) argue that the common perception of qualitative and quantitative research is quite narrow. Instead of viewing quantitative research as primarily numerical and qualitative as non-numerical, they expand the definition through four elements or categories. The categories are research philosophy, research approach, characteristics, and research strategies, all contributing to the decision on the methodological choice. Given that this report will apply a positivistic research philosophy, an inductive research approach, a case study research strategy, and an interview design that are all typical for qualitative research, it is the most evident choice to adopt.

2.4 Research strategy

The next layer to process is that of research strategy. Both Saunders, et al. (2012) and Yin (2018) recognize that there are several factors to consider when determining the research strategy. All the different options have their individual benefits and drawbacks. The strategy or combination of strategies to choose for the research should be guided by several factors such as the formulation of the research questions, the research philosophy, the purpose of the study, the available time frame, or the availability of data (Saunders, et al., 2012).

2.4.1 Case study as a Research strategy

Case study research is a powerful tool used to better understand and give answers to questions such as *'why?', 'how?',* and *'what?'* in explanatory studies (Saunders, 2012; Yin, 2018).

Yin (2018) formulates three different situations that are relevant when deciding whether to choose a case study as the research method. The first one is the formulation of the research questions as discussed above. The second situation is that the research does not require control over behavioral events and thirdly, the research focuses on contemporary events, all of which are corresponding to the conditions of this thesis and are factors affecting the decision. There are four types of cases when doing case study research, the different types are illustrated in Figure 2.2 below.

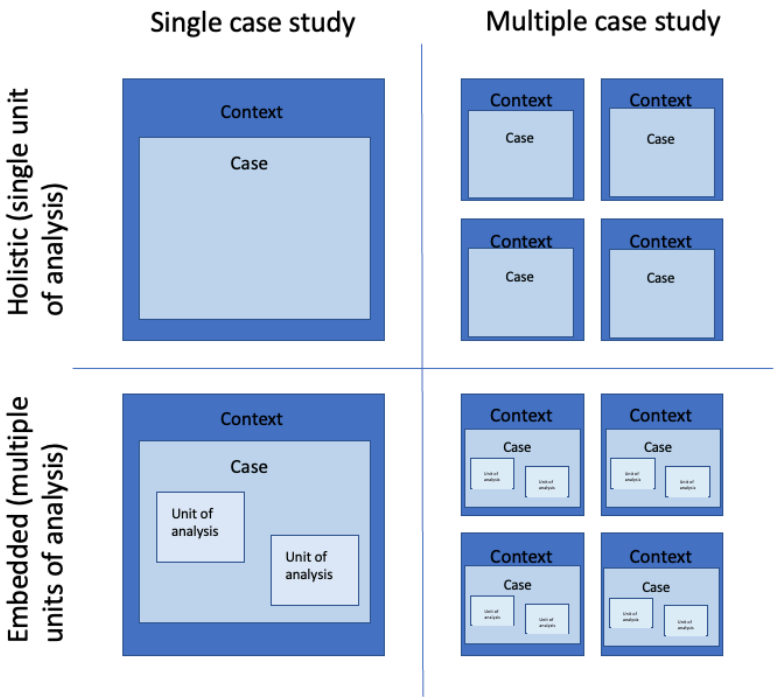

Figure 2.2. The four types of case studies. Source: (Yin, 2018).

There are two things that determine what type of case design to choose. The horizontal axis illustrates the choice between single or multiple case designs, and the vertical axis illustrates whether to use one single or multiple units of analysis.

2.4.2 Selecting type of case study

Yin (2018) presents five rationales or circumstances that can justify the use of single case study research. These five justifications are explained in Table 2.1.

Table 2.1. Five rationales for Single Case Study Research. Source: Adopted from Yin (2018)

Rationale	Description	Example of use case
Critical	Used when the findings are critical to the theory or propositions. Predetermined set of hypotheses that are believed to be true are investigated.	Can be used to determine whether the predetermined propositions can be confirmed or should be challenged.
Unusual	To be used for a case that is deviating from theoretical norms or everyday events.	Investigating specific injuries or diseases, global disasters.
Common	Used to capture everyday events or repeating situations, circumstances, or conditions.	Investigating or mapping behavioral changes and relationships.
Revelatory	Used when circumstances have changed so that the researcher has an opportunity to analyze and evaluate previously inaccessible phenomena.	Research on units of analysis that are unaware of the study or in natural settings.
Longitudinal	Studying the same single case in multiple, different, points in time.	Used to understand changes, evolvements, and differences over extended periods of time.

This thesis will employ the first type of case study, called single-case study (horizontal axis in Figure 2.2). The decision is rationalized since it fulfills the description of the common rationale in Table 2.1. This research aims to analyze and evaluate the daily work performed in Alfa Laval GPHE. Furthermore, it is of interest to investigate and map relationships between different departments and the alignment between them.

The second decision is to choose whether to choose a holistic or embedded unit of analysis (vertical axis in Figure 2.2). Yin (2018) explains that it is important to understand whether the research aims to understand a case on a broader level, holistically, or dividing the matter into several individual units. As this thesis uses the strategic alignment of the S&OP process at Alfa Laval GPHE as the single unit of analysis, the best-suited choice is a holistic approach.

Single case study research has the advantage of providing great depth on the unit of analysis, combined with a literature review which provides a broader perspective on the context of the specific case (Yin, 2018). However, it does come with some drawbacks that are important to both mention and consider. There is a possibility that the results and conclusions that can be drawn from the research become quite limited to the unit of analysis, and that there are few general scientific benefits of the study (Bennet, 2015). Another potential drawback is that there could be a possible bias between

the researcher and the unit of measure for the research (Reige, 2003). Yin (2018) explains that a thorough analysis of the case candidate is required to ensure data availability and that there are limited risks of misrepresentation, which mitigates the posed drawbacks to the single case study research.

2.5 Time horizon

The determined time horizon for the case study dictates how the data can be collected. It can either be cross-sectional in which the data is depicted by a current "snapshot" in time, or it is longitudinal where data is collected multiple times to provide an image of how the phenomenon changes over time (Saunders, et al., 2012). Given the time frame for this research, a cross-sectional study has been opted for. Data on the phenomena will be collected through a series of interviews and a literature review, conducted over a short period of time. When the data collection phase is completed to a satisfactory extent, it will be analyzed, and conclusions will be drawn. There is a chance that some interviewees may be revisited for supplementary questions, and that additional literature may be reviewed. However, not in a manner that resembles a restart of the entire collection phase, which is the process of longitudinal studies.

2.6 Techniques and procedures

The last and innermost layer of the research onion is techniques and procedures. With the other layers peeled back, the setting of the research has been defined. The following subchapters will in detail explain how the theories have been developed, how the interview guide will be designed, and how the collected data will be analyzed.

2.6.1 Research design

Runeson and Höst (2009) describe that there are five major process steps that should be examined when conducting case study research. The steps and their purpose are formulated in Table 2.2.

Table 2.2. Case Study Research Process. Source: (Runeson & Höst, 2009)

Step	Process	Purpose
1	Case study design	Defining objectives, timeframe, and deliverables
2	Preparation for data collection	Procedures and protocols, data collection form
3	Collecting evidence	Interviews and literature review
4	Analysis of collected data	Evaluation of answers and pattern matching, cross reference answers with theory
5	Reporting	Answer research questions, provide recommendation and conclude the research

These five steps have been adopted and the research design for this thesis is illustrated in Figure 2.3 below, it contains the major process steps and what subtasks that are to be performed.

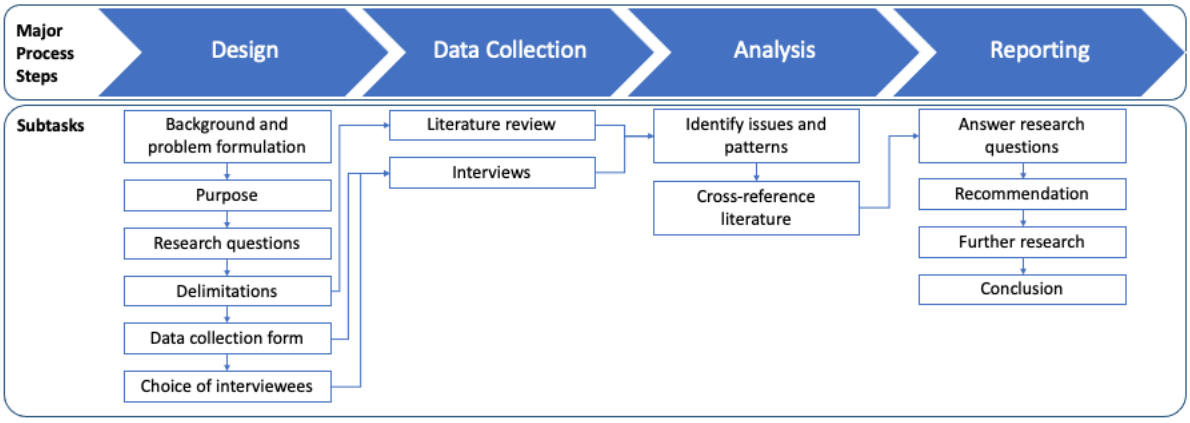

Figure 2.3. Research design method. Source: Adopted from (Runeson & Höst, 2009)

2.6.2 Interview design

Yin (2018) argues that collecting data when performing case study research is not merely the act of recording instruments in laboratories. Instead, the procedure requires a level of instant adaptability depending on the direction of the conversation and answers. The provided information and data from interviews must be interpreted immediately so that the conversation can be steered in a direction that illuminates the most relevant knowledge. Simultaneously, the interviewer must also remember to remain unbiased when forming any inferences to not neglect any important details. However, while it is necessary to consider new perspectives and stay open to adjustments, the interviewer must also realize when the interview is treading towards a completely new direction, other than what is relevant to the study. To adhere to this knowledge, it must be considered that there is no single way or set of direct questions that can be predetermined for interviews. Especially so when interviewing several different roles in the company as intended for this study.

As the purpose of the interviews is to gather information and explore problems, the interview guide will be unstructured but contain some predetermined questions to revert to if needed. The interview design used in this thesis is adopted by Yin (2018). He suggests preparing a data collection protocol where the interview guide is broken down into four main subsections. It provides the benefit of serving as an agenda for the interviews. The first section (Section A) is an overview of the case study with objectives, targets, and potential issues. The second section (Section B) contains the data collection procedures, names, and roles of the interviewees as well as any expected preparation. Section C contains the interview questions, this section has been constructed so that it encourages open and descriptive answers, leaving much room for the interviewee to explain their stance. Together with the invitation to participate in the interviews, sections A and B will be attached so that both the interviewee have time to do any potential preparation but also to remain time efficient. The data collection protocol can be found in Appendix A. The primary bulk of the data gathered through interviews will be on one single occasion, with optional additions gathered through emails. Table 2.3 shows the interviewees included in this thesis and their roles.

Table 2.3. Description of roles of interviewees.

Role	Description of role
S&OP Manager	Has ownership of the S&OP process. This includes an administrative responsibility that makes sure that the iterative steps are followed and that inputs are concluded and addressed.
Global Supply Planner	Has responsibility to convert demand forecast to supply actions for all factories across operations. Also works closely with developing the S&OP process.
Business Controller Product Group	Has responsibility to monitor operations so that they execute and perform in line with the goal of the BU. Also focuses on managing and developing operations in terms of capacity and supply.
Operations Development Manager	Has a cross-functional responsibility for projects across operations that aim to improve process performance in general.
Operations Developer	Same as above, but not on a managerial level.
Sourcing Manager Business Unit	Has responsibility of making sure that purchasing in operations is performing up to standard and in line with strategy. Also represents the BU in the global sourcing forum.
Product Manager	Has ownership of the products throughout its lifecycle. From early design stages and market introductions to removing the product from the market, they are owners of the products and projects to do so.
Manager Product Management	Has responsibility for a certain segment of assortment and the development of it. Also has responsibility for the product review in the S&OP.
Business Controller Business Unit	Has responsibility over BU in terms of sales, cost and financials. Monitors that the BU is operating in the right way and addresses issues that occur.
Equipment Sales Manager	Has overall responsibility for the sales of heat exchangers for segments like cities, buildings, and data center. Works with analyzing market demand and trends to position GPHE's product segment.
Process Sales Manager	Has overall responsibility for sales of heat exchangers for the process industry segment. Generally, a more technically intense sale that requires case specific solutions to be developed.
Business Unit Manager	Has overall responsibility for the business unit and its performance. The role includes managing all the included business functions and aligning the BU with the goals of the division and the company.

2.6.3 Theory development

Theory development for this inductive case study will primarily be based on a meticulous literature review and interviews with employees at Alfa Laval. There are some key aspects of why a literature review should be performed. It can support or contradict the research questions, theories, and hypotheses. Furthermore, it can also be used to further develop them. It provides the researcher with a foundation on which the research will be based and explains the terminology and concepts that will

be handled. Finally, it can be of assistance when analyzing and developing the collected data and using the data to draw conclusions (Rowley & Frances, 2004).

The main sources of research and information used for this project will be books, web resources such as search engines (e.g., LubSearch, Google Scholar), and databases (e.g., Emerald). To maintain a high level of scientific assurance when choosing from the vast amounts of publications available, Rowley and Frances (2004) suggest the following evaluations, which have been adopted in this thesis.

Evaluating the credibility and relevance of a book:

- The general topic of the book is matching that which it is being referenced for, and it has a high relevance to the topic.
- Depending on what the book is referenced for, its publication date must be recent to not give outdated information.
- The publisher of the book should be of good reputation in the field that the book is regarding.
- The book must include references to associated literature and include credits to external research.

Evaluating the credibility and relevance of a web resource:

- The resource must be written for a relevant target audience.
- The publishing organization or publisher should be of good reputation in the field that the web resource is regarding.
- Depending on what the resource is referenced for, its publication date must be recent as to not give outdated information.
- The resource must include references to associated literature and include credits to external research.
- The resource has selected keywords that are relevant to the topic it is referenced for.
- Number or citations and related articles can be used as an indicator. Where applicable a reverse and forward search of the citations will be performed.

If all the above is fulfilled, the book or web resource is regarded as a credible source of information and is allowed to be used in this thesis. Important sources of information for this thesis have been Bozarth and Handfield (2019), Fisher (1997), Grimson and Pyke (2007), and Nakano (2020) to mention some. They have been key sources of information used to develop theories for this thesis.

2.6.4 Qualitative data analysis technique

Yin (2018) notes that the development of case study analysis is little to none. Due to the difficulty of comparing case studies that have been made independently of each other, there are few generalized procedures or guides readily available to apply to a study (George & Bennet, 2005). Instead, much is dependent on the conclusions that the researcher draws from the data, and how they decide to interpret it. From there, evidence can be presented to support the interpretations and assurance can be created by considering alternative perceptions (Yin, 2018). No matter what strategy is used for data analysis, either adopted for a model or formulated solely for the study, an analytical technique should be selected (ibid).

With this knowledge a general analytical strategy has been developed and applied throughout the analytical phase, its purpose is to create a tie between the case study data and the concepts of interest (Yin, 2018). The selected strategy starts with the research questions and then iteratively revolves around the data collection, defensible handling, interpretation of data, state findings, and drawing conclusions, illustrated in Figure 2.4.

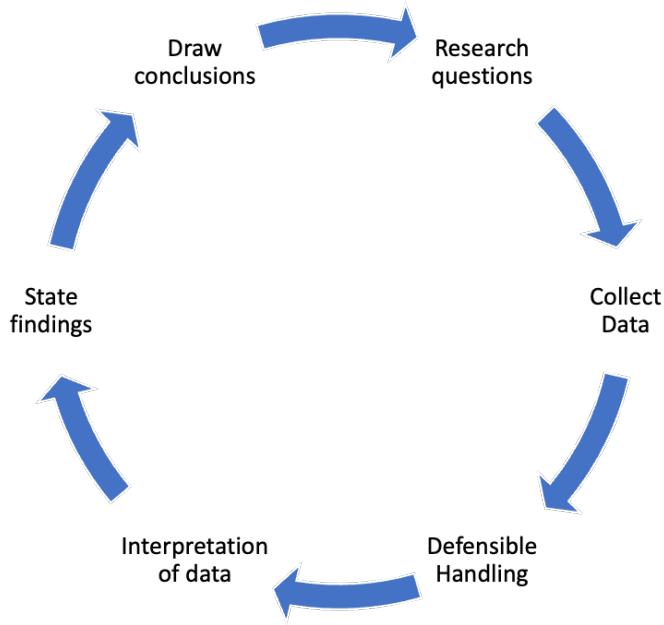

Figure 2.4. General iterative analysis strategy. Source: (Yin, 2018)

For this single case study, pattern matching will be the primary analytical technique. The technique is used to find empirical patterns in existing research and literature, subsequently matching them with the findings from the interviews in this case study (Yin, 2018). It allows for the identification and highlighting of similarities and differences in the data. The data collected from the interview phase of this study will be summarized and explained in the analysis chapter. Given that these patterns are substantiating the theories formed for this research, the validity of the predictions is increased. Pattern matching is also a technique that ensures the internal validity of the case study research, see Internal validity below.

2.7 Research quality and credibility

Case study research has many advantages and applications in the academic world. However, the accuracy and legitimacy of their results are often subject to debate (George & Bennet, 2005) (Reige, 2003). The credibility and validity of this thesis are ensured by combining an extensive literature review with interviews of key stakeholders at Alfa Laval. Furthermore, the research design quality is validated by applying *the four tests method*, a method used to determine the quality of social research studies (Yin, 2018). The method is broadly accepted in scientific contexts and is used and regularly referenced in journals, reports, and publications (ibid). The four tests that are used to validate the design quality are: Construct validity, Internal validity, External validity, and Reliability. How and why the tests are performed in this thesis are explained further in the next sections.

2.7.1 Construct validity

All measures are to some extent flawed since they inevitably contain various degrees of random error (O'Leary-Kelly & Vokurka, 1998). When performing a case study, critique is often brought up that the researcher has failed to develop a sufficiently solid foundation for the research. Ultimately that there is a risk of the study being subjective to the researchers' preconceived notions (Reige, 2003). In turn, the failure of not developing a set of operational measures poses the risk of using data that only confirms the perceived notions of the research being performed, thus not considering all perspectives (Yin, 2018). To prevent this, the first test performed, construct validity, which is used to ensure that the research does not contain structural errors and assessing the degree to which the targeted variable is measured (O'Leary-Kelly & Vokurka, 1998). This thesis ensures the construct validity by

interviewing several employees, which will present a pattern, or a lack thereof, in their answers. From there, their thoughts and answers will be cross-references towards the theory gathered in the literature and other studies to investigate whether there are correlations with other measures of the same construct. Then if deemed necessary, interviewees can be invited to one or more follow-up interviews if clarifications from either party are needed.

2.7.2 Internal validity

Internal validity is a test that often is performed in experimental research. It aims to discover the relationships between root causes and results, distinguishing them from variables that are associated with each other but not causally related. However, the applicability of the test is not natural for case studies, instead, it must be customized through one or more of the following analytic tactics: pattern matching, explanation building, addressing rival explanations, or using logic models (Yin, 2018). As previously mentioned, pattern matching will be used to ensure the internal validity of the research. It is used to identify and investigate what and especially how foreign factors might affect the answers provided in the interviews in a structured manner. One key benefit of this test is that awareness is raised that there might be bias or inaccuracy in the answers provided from the interviews, thus the potential effect it might imply can be accounted for.

2.7.3 External validity

When doing case study research there are several ways to influence or steer the research in a specific direction. It can either be conducted in a manner that only allows for internal use of the results, providing no benefit for those outside of the case study, or it can be aimed to allow for a generalization of the results for external interpretation. A significant factor that affects this is the research questions, depending on how they are formulated the study can either allow or inhibit the external interpretation and validation of the results. (Yin, 2018). The third test, External validity, captures and identifies the extent to which the conducted research performs an adequate test of theory (Calder, et al., 1982). To ensure external validity of this research, the research questions have been carefully selected so that the results can be interpreted on a general level. In addition to this, the primary references and keywords have been selected so that the literature review provides, for the research area, general information, not only information applicable to Alfa Laval.

2.7.4 Reliability

The reliability of a study or research explains the extent to which the results of the said study can be replicated at a later point in time. The fourth test, Reliability, ensures that the methods and procedures used in the research are documented to a satisfactory degree (Yin, 2018). The reliability of the research in this thesis is established by using the previously mentioned data collection protocol in Interview design.

3 Frame of reference

This chapter aims to build a theoretical foundation within relevant areas of supply chain management that will serve as a basis for the purpose of this thesis. The structure of the chapter follows a logical order that seeks to raise the reader's knowledge of how performance can be enhanced through supply chain management and the challenges that follow. The areas covered are: supply chain management, S&OP, operations management, supply chain strategy, and organizational collaboration. The chapter is also concluded with an analytical model that provides an overview of the following sections of the thesis.

Figure 3.1 illustrates the logical order of theories covered and how they will chronologically raise the reader's knowledge in line with the purpose of the thesis. The relevance of all these topics and how they contribute to the case study is illustrated through a theoretical framework at the end of the chapter, see Figure 3.23. This framework shows how each research question is intended to be answered with the literature review and empirical data.

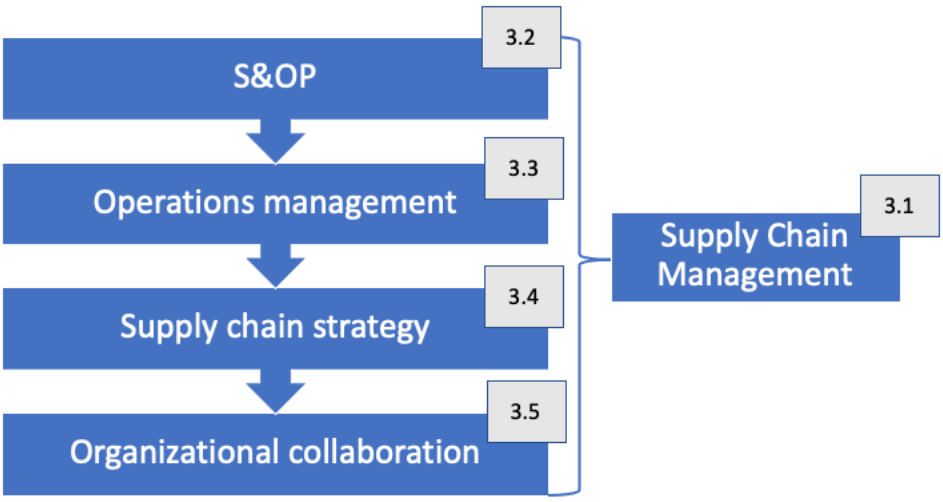

Figure 3.1. Illustration of how theory will be structured to formulate a literature review. Created by authors.

3.1 Supply chain management

This section aims to explain the principles of supply chain management with a focus on describing inter-functional coordination. This is done by highlighting necessary activities in a supply chain, defining its purpose, and examining how functions together creates value.

Mentzer, et al. (2001) argue that despite its popularity, there is confusion about the meaning of "supply chain management". Because of the complicated terminology, the concepts of supply chain management have become hard to understand and use in practice. However, the definition of "supply chain" is less varied between authors. A supply chain can be defined as "*a set of three or more entities directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer*" (Mentzer, et al., 2001). Following this definition, Mentzer, et al. (2001) categorize three different degrees of supply chain complexity: direct supply chain, extended supply chain, and ultimate supply chain. Figure 3.2 illustrates these three categories and their relationship and Table 3.1 describes them.

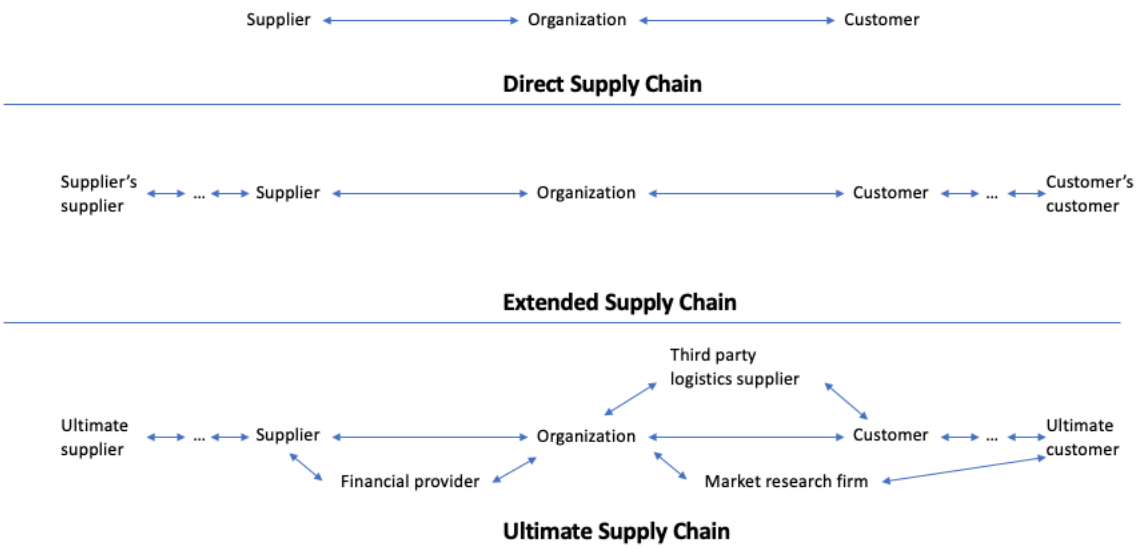

Figure 3.2. Degrees of supply chain complexities and relationships. Source: (Mentzer, et al., 2001).

Table 3.1. Description of degrees of supply chain complexities. Source: (Mentzer, et al., 2001)

Degree of complexity:	Description:
Direct supply chain	Consists of a company, a supplier, and a customer. These are involved in an upstream/downstream flow of services, products, information, and finances.
Extended supply chain	Also includes the suppliers of the immediate supplier and customer of the immediate customer. These are involved in an upstream/downstream flow of services, products, information, and finances.
Ultimate supply chain	Includes all organizations involved in all the upstream and downstream flow of services, products, information, and finances.

Following the description of a supply chain by Mentzer, et al. (2001), the authors review many definitions in their article, upon which they conclude a single definition for supply chain management. "*The systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole*" (Mentzer, et al., 2001). This definition suggests that supply chain management should not only look to improve the performance between businesses, inter-company alignment but also within the business and its function so-called intra-company alignment. In other words, a company should not only integrate with others but also within itself.

3.1.1 SCOR model

Supply Chain Operations Reference (SCOR) is a model used by businesses to structure and understand their supply chain. The model serves as a high-level framework of business processes and describes individual processes in detail. By standardizing descriptions of processes, relationships, and metrics, it helps define supply chain management. There are different levels on how specific supply chain activities can be described. In the highest overview, level 1, the SCOR model categorizes five process

areas that supply chain activities should be structured around. This model captures the essence of the structure of activities and enables a general understanding (Bozarth & Handfield, 2019). Figure 3.3 shows the SCOR level 1 overview.

The five areas in SCOR level 1 are:

- **Source** – Processes that include procuring goods and services necessary to meet actual or planned demand.
- **Make** – Processes regarding the transformation of a product to finished goods to meet actual or planned demand.
- **Deliver** – Processes which provide finished goods and services to meet actual demand or planned demand.
- **Return** – Processes that include the return or receiving of products.
- **Plan** – Processes associated with balancing all resources with requirements to operate supply chain.

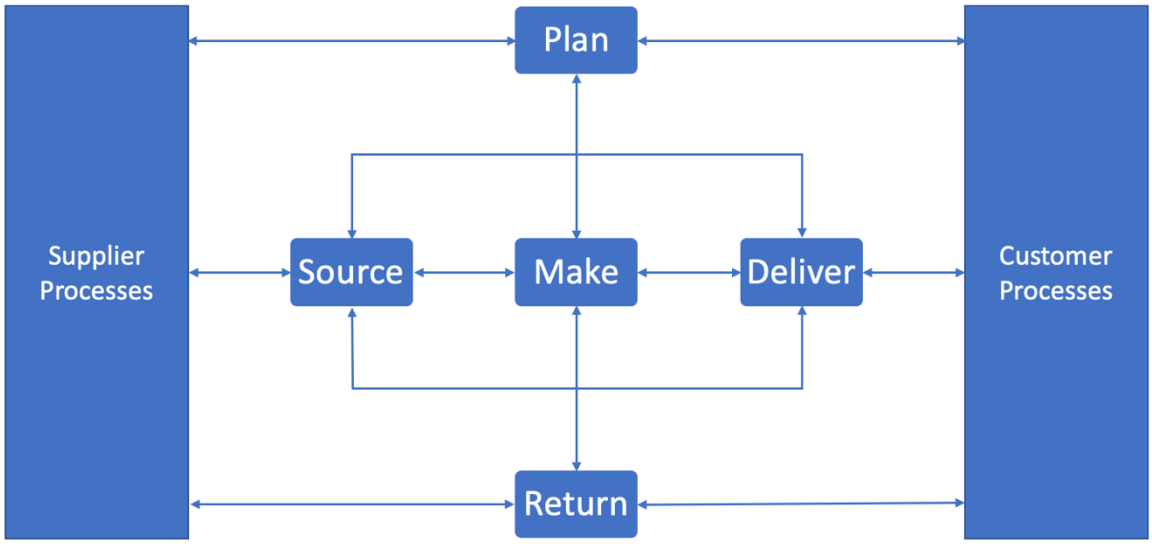

Figure 3.3. Overview of SCOR level 1 processes and relationships. Source: (Bozarth & Handfield, 2019)

3.1.2 Inter-functional coordination

The SCOR model defines a critical set of activities in a supply chain. In context to this, Mentzer, et al. (2001) presents a conceptual model for supply chain management, Figure 3.4. This model shows how a supply chain can be pictured as a whole and how all integral parts relates to creating customer satisfaction, value, profitability, and competitive advantage. Highlighted in this model is the inter-functional coordination, meaning the traditional business functions within a company, for example, sales, production, and purchasing. Mentzer, et al. (2001) claim that one of three characteristics of supply chain management is the effort to strategically orient toward synchronization and convergence of intra-company and inter-company capabilities as a whole. For supply chain management to reach its full potential, these functions must coordinate through trust, commitment, risk, dependence, and behavior. Even though there are other integral parts necessary to create value, the synchronization of intrafirm capabilities is important (ibid).

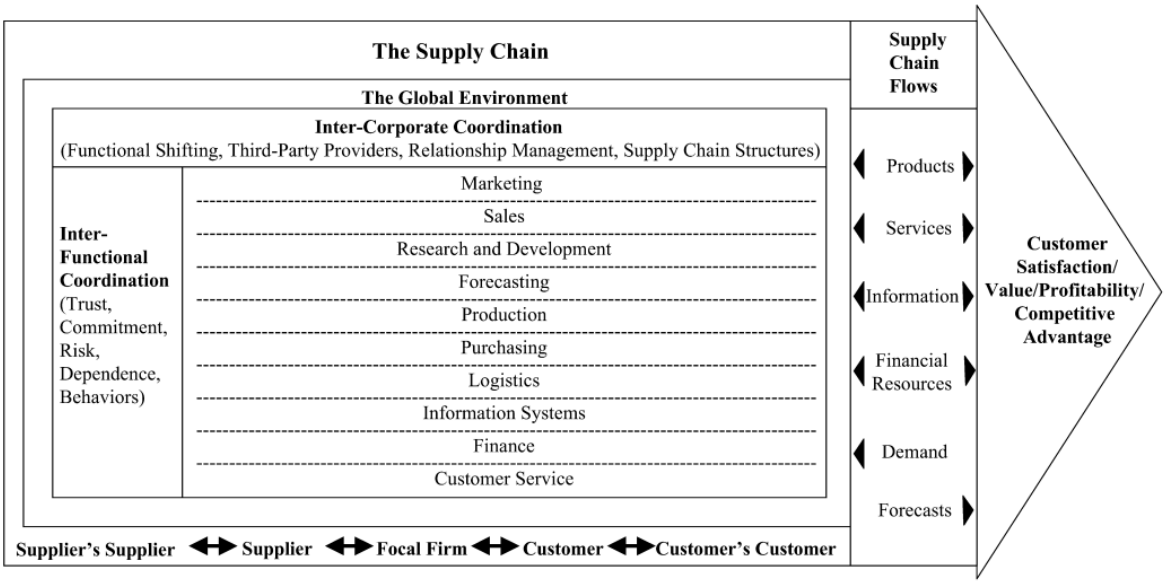

Figure 3.4. Supply chain management model. Source: (Mentzer, et al., 2001)

3.2 Sales and operations planning

This section aims to investigate and expand knowledge on the area of S&OP and how it links business strategy to short-term planning. It will present the integral business functions that are involved in the process and how they strive to reach their goals. Furthermore, success factors and potential pitfalls will be reviewed so that a holistic perspective on the theory of the process is obtained.

3.2.1 The S&OP process

Sales and Operations Planning is a business management process that can act as the link between strategic plans from corporate levels to operations (Grimson & Pyke, 2007). It operates to balance the capacity and demand of a producing unit in an organization. It is a cross-functional process that is considering inputs from several departments such as finance, sales and marketing, and operations. Ultimately, S&OP strives to create a consensus between the different business units such as sales, procurement, production, inventory, and deliveries (ibid). The people responsible for the process regularly meet to adjust and review their targets based on actual performance, changes in the market, and other factors. The process should operate on an aggregate level, bridging the gap between short-term operations planning and long-term strategic planning. Typically, the planning horizon spans from six months to three years (ibid), the different time frames are illustrated in Figure 3.5.

Figure 3.5. The different planning time horizons. Created by authors.

3.2.2 The five iterative steps

Grimson and Pyke (2007) explain S&OP as a process that generally follows five steps, typically iterated once every month, illustrated in Figure 3.6. These five steps are considered by the authors as the general process. However, the authors also mention that there are of course alterations to the process which can be caused by what industry the organization is operating in, the maturity of the organization, production lead times, or organizational structure. These variations can affect, for example, the concerned time horizon, the frequency of the iterations, or what representatives are participating in the process.

Figure 3.6. The five steps of S&OP planning, Created by authors.

The first step of the process, demand planning, is a meeting where the sales team that determines a future demand forecast, independent of what can be produced. Instead, they are only considering what can be sold to the customers and in what quantities. Using reviews from former meetings and actual outcomes of their previous plans, they update their forecasts and include potential new product demands. Furthermore, the team considers market responses to promotions, competitors, seasonality, and more within the determined S&OP planning horizon. This level of detail is important to provide accurate forecasts that can be used to form actions and decisions.

The second step, supply planning, involves the operations team where they are tasked to translate the demand forecast into a plan of how much of what products can potentially be produced given current circumstances. The circumstances include considering future production and supply capacity, shifts and man-hours, current and eventually future inventory strategies, and resource planning decisions. After these factors are determined, they continue by creating an initial capacity plan based on the forecasted demand plan. To ensure accurate forecasts, the operations team may often apply material resource planning modules which can aid in the process.

Next, the third step is optimizing and decision. In this step the sales team and operations team take their forecasts created in the previous steps and meet in a formal setting to develop one single operating plan. This plan is based on inputs from both forecasts, data from reviews of previous meetings and decisions, and potential changes in the overall strategy. In this step, the S&OP stakeholders and parts of the organization's executive management are tasked with making general decisions and setting targets, trying to optimize the balance between their demand and supply capacities. As the different participants of this third step all have different priorities, they need to negotiate and consider different trade-offs before they agree on one plan that will be implemented, see Figure 3.7.

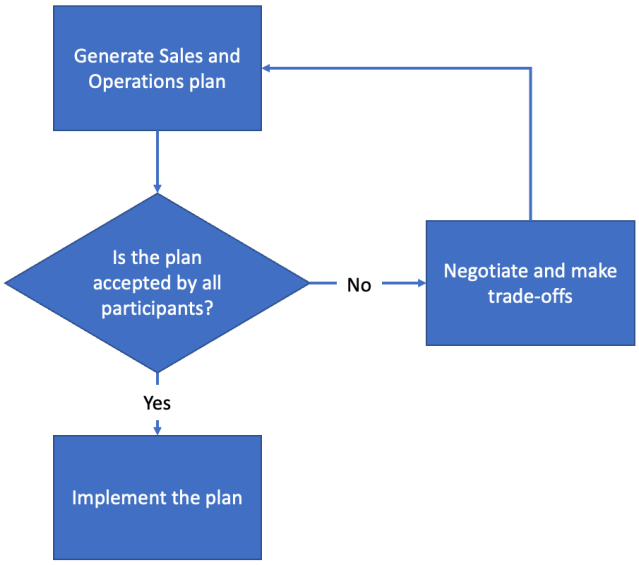

Figure 3.7. Iterative process of generating S&OP plan. Source: (Bozarth & Handfield, 2019)

Followingly, in the fourth step, the S&OP team needs to distribute and implement this plan so the master- and production planners can act on it. It must be made sure that the entire business unit is aligned on what the decided targets for the coming period are. This can include potential increases in required inventory levels, extra production hours, or marketing campaigns. In this step, it is vital that the communication between business functions is at a satisfactory level and that the execution of the plans is carried out in all operation facilities.

The fifth and final step is reviewing and concluding the results of the implementations and changes. Because the process is iterative in nature, measuring results and effectiveness is essential so that the process can be refined for the next iteration. Furthermore, the measurements are used in the forecasts and are necessary to ensure their accuracy. What elements or dimensions should be monitored, and how, should vary from industry and use case, but common Key Performance Indicators (KPIs) used include current inventory levels, safety stock, and turnover rate for inventory. Time-to-market, ramp-up time, and development cost for R&D or innovative operations and various cost metrics and sales numbers are of interest to sales and finance. After the five steps have been completed, the process starts over, and a new iteration begins.

3.2.3 Influencing factors

Management support on implementation

The S&OP process is simple to understand, and the potential benefits can be easily visualized. However, it is difficult to properly implement so that the promised value-adding benefits are obtained (Grimson & Pyke, 2007). It often calls for large changes in the organizational structure for the process to be properly implemented and value-adding to the organization. If the process is not provided with sufficient resources and attention in the organization, it will instead drain capacity from a potentially already strained planning function. Grimson and Pyke (2007) argue that a success factor in the implementation of S&OP is using pilot projects on either single production facilities or product families. By implementing the process in these pilots and proving the capabilities of a well-executed S&OP process, senior management will realize the potential benefits that can be gained from a successful implementation followingly grant the required resources. Implementing the process in a top-down fashion enables a rapid adjustment to the new process change. This managerial support is also stated by both Bozart and Handfield (2019) and de Oliveira Pedra Romão et al., (2022) as a key factor to make the S&OP a success. Furthermore, having the necessary sponsorship and support from executive management early in the process ensures that the various stakeholders in the S&OP begin to develop their knowledge of S&OP, which becomes an important factor for its future effectiveness.

Executive Commitment

The culture and leadership of an organization is an important mechanism that enables a well-functioning S&OP process (Tuomikangas & Kaipia, 2014). This is supported by Swain, et al., (2016) who argue that having the support of top executive management engagement in the S&OP process is imperative to ensuring its effectiveness. As previously mentioned, S&OP is a tool that supports an organization to execute on its strategic plans. Van Hove (2017) argues that by increasing executive engagement toward S&OP and clearly communicating the outcomes of the iteration, a better strategic alignment throughout the organization can be achieved. As employees will see how their jobs contribute to the strategic targets of the BU, the overall business goals will be better understood throughout the organization. The author continues to state that if the CEO of a company drives both cultural and behavioral change through S&OP, the process will over time be more effective and value-adding. Furthermore, Van Hove (2017) also mentions that a lack of this managerial support, which can be reflected in the mindsets or behaviors towards the process, can affect its development negatively. Instead, the executive management must demonstrate a willingness to comply with the process and act as role models for it to be accepted and to function properly.

Knowledge development

Bozarth and Handfield (2019) argue that ensuring that all participating parties obtain a deep understanding of the process, their role in it, and its benefits, is more important for the implementation's success than rapid scale-up. This perception is also supported by de Oliveira Pedra Romão et al., (2022). Followingly, Bozarth and Handfield (2019) speak of the fact that this

understanding and knowledge trumps having software or computer aids developed at an early stage of the implementation. Later when deepened understanding of the process is obtained, more advanced tools for forecasting and sharing data can be developed and implemented (Tuomikangas & Kaipia, 2014). The goal of an S&OP implementation is not the organizational change itself, rather it is a tool for profit optimization within the organization and changes are a necessary success factor in its implementation (Grimson & Pyke, 2007). Making sure that the business functions affected by the S&OP process, both directly and indirectly, truly understand the benefits and values added by it becomes imperative for its success. This can be achieved through a change management initiative in collaboration between HR and the executive managers (ibid).

Trust and transparency

Van Hove (2017) states that achieving an appropriate level of trust in the company culture is imperative to nurturing and maintaining a sustainable and efficient S&OP process. Followingly, if an increase in trust is driven by the CEO of the organization, organizations can see benefits such as decreased employee stress, increased earnings, and high productivity throughout the integral functions of the process. On the same topic, Mello (2010) argues that trust is a prerequisite to openness and collaboration in S&OP and that no employee should be hesitant to speak troublesome truths. An appropriate level of transparency is a necessary precursor to allow for discussions that open up to find solutions to these problems. Enabling and maintaining a company culture that emphasizes the importance of the collaboration that comes with high trust and transparency will promote the behaviors that allow for reaching the goals of the S&OP process. A failure to recognize the importance of them will instead hinder the performance of it. By having executives practise and emphasize behaviors that improve trust, the S&OP process can be optimized further (Van Hove, 2017).

3.3 Operations management

In this section, concepts, and theories relevant for operations management will be defined, more specifically capacity management and inventory management.

3.3.1 Purpose and definition

Bozarth and Handfield (2019) define operations as "*the collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services*". In contrast to a supply chain perspective, operations is a philosophy that focuses on the internal functions within an organization and its relationship. Operations can be viewed as a transformation process that takes inputs and transforms them into outputs that have value to the customers. Figure 3.8 shows this relationship. Followingly, operations management is concerned with the planning, control, and scheduling of the activities that transform an input into an output (ibid).

Figure 3.8. Operations as a transformational process. Source: (Bozarth & Handfield, 2019)

Two fundamental topics of operations management are capacity management and inventory management as they enable or constrain how much supply that can be produced with regard to demand (Song, et al., 2020).

3.3.2 Capacity strategy

For products to be produced and delivered to customers, two types of assets are needed: capital (money, property, equipment, etc.) and labor (humans). Central for capacity management is how to choose between these assets to enable a capacity that can maximize value (Song, et al., 2020).

Changing capacity

Bozarth and Handfield (2019) claim, through the theory of constraints, that a system of processes cannot deliver more than the constraints of its integral parts, thereby highlighting the importance of raising the performance of certain parts of a process to raise overall capacity.

On the topic of capacity strategy, a structural decision category in a manufacturing strategy (Olhager, et al., 2001), Hayes and Wheelwright (1984) argue for three topics of capacity that need to be addressed: type of capacity, amount of capacity added or reduced, and the timing of the capacity change. Olhager, et al., (2001) mention that the topics of type and amount are normally discussed under the "sizing problem". Central to the sizing problem is the scale of change. Capacity can normally be changed in discrete steps with ample lead time. For instance, adding a new machine or facility leads to a significant capacity change in a stepwise manner. In this context, optimal change becomes vital. Furthermore, the timing of capacity change is concerned with the balance between the forecasted demand for capacity and the supply capacity. If there is a capacity demand surplus, material utilization will be high and consequently, the cost profile of operations will be low. However, at the risk of losing customers since all demands cannot be met. On the other hand, if there is a capacity supply surplus, a higher cost profile will follow, enabling more flexibility and delivering reliability. The question of how to manage capacity becomes a strategy that implies trade-offs. On the long-term planning horizon, typically 1-5 years (similar to strategic planning horizon in Figure 3.5), Olhager, et al., (2001) discuss two strategies: lagging and leading demand.

Olhager, et al., (2001) argue that the lead strategy strives to have a surplus of capacity so that it can support changes in volume and provide reliable lead times. When there is a positive change in demand, capacity should be added in anticipation so all demand can be met. When demand is decreasing, capacity is reduced so that it follows demand but never so that the demand exceeds supply capacity. On the Other hand, the lag strategy aims to have high utilization of resources to enable a lower cost per unit. This is achieved by producing as much as possible and add adding capacity as a reaction to increasing demand. When demand is decreasing, capacity should be reduced so that utilization remains high. Furthermore, Olhager, et al., (2001) mention a combined approach, a tracking strategy, where the objective is to track demand as close as possible and minimize deviations between capacity and demand. Figure 3.9 illustrates the strategies.

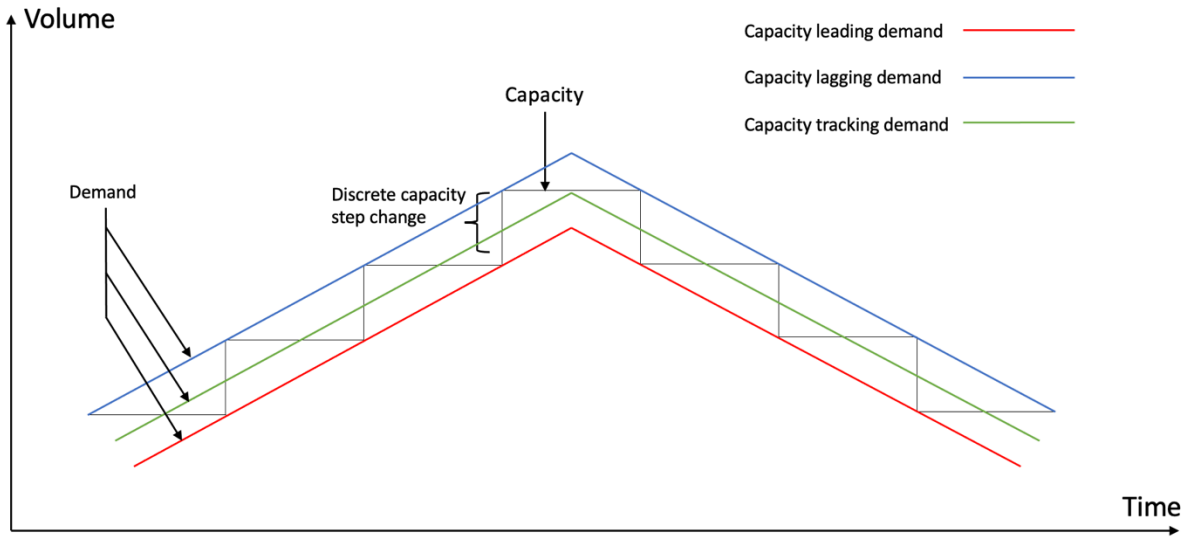

Figure 3.9. Leading, lagging, and tracking strategy. Source: (Olhager, et al., 2001)

To conclude, Olhager, et al., (2001) links capacity strategies to S&OP's definition of planning strategies to address long term capacity management. The authors claim that a lead strategy enables S&OP to operate with more freedom compared to a lag strategy. On the other hand, S&OP also affects capacity planning as the decision on how to modify supply, level and chase, influences the need for capacity. The level planning strategy levels production rate over planning horizons to meet demand. A chase planning strategy looks to match demand with production rate in a single period. Olhager, et al., (2001) summarizes the link between the two perspectives in a framework that illustrates the effects of combining the planning and capacity strategies. Figure 3.10 shows this relationship.

	Lead (capacity supply surplus)	(Track)	Lag (capacity demand surplus)
Chase	Combined strong focus on resource availability and flexibility.	← →	Limited opportunities to execute chase. Relying on sub-contractors. Frequent overloads and delivery problems.
(Mix / Combination)	↑ ↓	↖ ↗ ↙ ↘	↑ ↓
Level	Possibility to change the production rate if needed. Delay new capacity acquisitions.	← →	Combined strong focus on resource utilisation.

Figure 3.10. Link between planning and capacity strategies. Source: Olhager, et al., (2001)

Costs and revenue

Capacity enables a company to adapt output to demand. However, it does so at a significant proportion of an organization's cost. Yu-Lee (2002) explains that capacity costs can be categorized to cost of goods sold (COGS), sales, general, and administrative costs (SG&A), and property, plant, and equipment costs (PP&E). Table 3.2 describes these costs and how they relate to capacity management.

Table 3.2. Costs from capacity management. Source: (Yu-Lee, 2002)

Cost:	Description:
Cost of goods sold	Labor costs contributes to the COGS as people are involved in making the product. This includes direct and indirect labor. As capacity management directly controls the parameter of labor, COGS becomes a critical topic and cost.
Sales, general, and administrative costs	SG&A represents an organizations operating expense and includes various costs. Much of the labor capacity costs that are not covered in COGS are captured in the SG&A.
Property, plant, and equipment costs	PP&E includes the space, equipment, and systems a company buys and uses. Investments in PP&E will over time imply significant costs on a company.

Furthermore, apart from the impact capacity has on cost, Yu-Lee (2002) also argues that capacity highly determines a company's revenue. Products sold determine how much revenue a company can have. If there is a market demand that exceeds a company's capacity, then that cannot be met, and revenue will not grow. In this sense, capacity serves as a constraint on how much revenue a company can have. On the other hand, if the capacity allows more products to be supplied than what is demanded by a market then revenue will not grow (ibid). To summarize, having the right capacity correlates with revenue. Having understood the capacity impact on cost and revenue, the importance of accurately forecasting demand can be understood. An error in a forecast will misguide capacity management and majorly affect the financials of a company (ibid).

3.3.3 Inventory management

Anupindi, et al., (2012) describe inventory as the material that is flowing through processes within the boundaries of a supply chain. The primary goal of having inventory is to serve customers. However, the primary goal of inventory management is to minimize the investments in inventory, while still being able to meet functional requirements (Toomey, 2000). Simichi-Levi, et al. (2000) describe that as inventory is transformed through a supply chain it appears in three forms: raw material inventory, work-in-progress inventory, and finished goods inventory. Each of these needs its own control mechanism. Table 3.3 describes the different forms of inventory.

Table 3.3. Forms of inventory. Source: (Simichi-Levi, et al., 2000)

Inventory forms	Description
Raw material inventory	Basic material that companies buy from suppliers. Through a manufacturing process, the raw material inventory can be converted into final products.
Work-in-progress inventory	The raw material that is undergoing conversion to finished products. Also called semi-finished inventory.
Finished goods inventory	Saleable final products that have undergone transformational processes.

Inventory can have different forms, but inventory can also be categorized into several different stock types. Meaning, what purpose it serves from a storing perspective. The two most common ones are cycle stock and safety stock (Bozarth & Handfield, 2019). Cycle stock refers to the stock that is being received, gradually used up, and then replenished again. It can be considered "active" inventory as

companies continuously use and replenish it. Safety stock is a type of extra inventory that companies must have to ensure that their operations can keep going if something were to happen to delivery lead times or demand levels, for example. Its purpose can be described as a fire extinguisher, it is there if something were to happen (ibid). Table 3.4 describes other types of inventories and the reason for having them. Figure 3.11 illustrates inventory level over time with a categorization of the different stock types.

Table 3.4. Other types of inventories. Source: (DeSmet, 2021).

Stock types:	Description:
Pipeline stock	Inventory that is "in-transit" due to work-in-process or transportation lead time
Anticipation stock	Inventory held in anticipation of future customer demand
Strategic stock	Inventory held to manage potential risk, for instance future shortage of supply

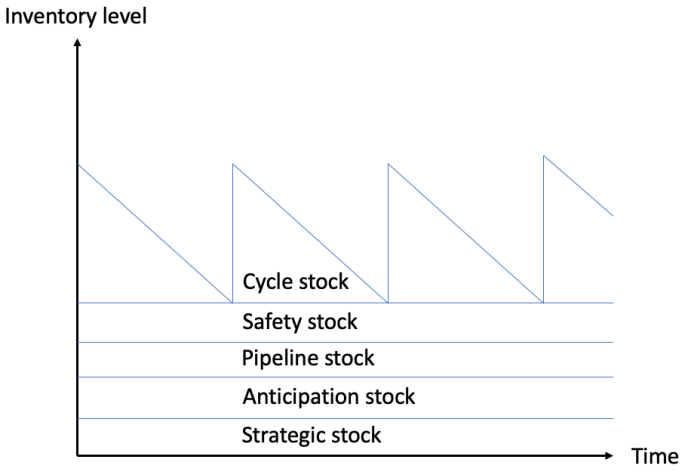

Figure 3.11. Inventory levels over time. Source: (DeSmet, 2021).

Inventory drivers

Inventory ties up capital and space, therefore it is not something that companies want to have in excess as resources could be allocated elsewhere. Bozarth and Handfield (2019) argue that companies have an inventory surplus because of inventory drivers, which is business conditions that force companies to hold inventory. Depending on how well companies manage these drivers they can reduce inventory throughout their supply chain.

Inventory drivers come from uncertainty in supply and demand, which companies inevitably are exposed to throughout their supply chain. Supply uncertainty refers to the uncertainty that comes from the upstream end of the supply chain (suppliers). These uncertainties can for instance be the result of low product quality, delivery inaccuracy, and supply shortage. Because of supply uncertainty, a company is forced to have extra inventory to be able to operate with these present risks. On the downstream (customer) side of the supply chain, a company faces demand uncertainty which can be an inventory driver. This is because of unforeseeable risks of fluctuation in the demand for products. If identified, inventory drivers can be addressed and reduced. For instance, a supplier quality problem can be targeted with a quality improvement program which would raise the overall quality and decrease supply uncertainty (Bozarth & Handfield, 2019).

Inventory as a tool

Companies may use inventory for more reasons than just to protect their operations against potential supply disruptions. Anupindi, et al., (2012) argue that possible benefits that come with carrying inventory are economies of scale and production capacity smoothing.

Economies of scale refer to a process whose average unit cost of output decreases with volume. In a supply chain, economies of scale can, for instance, be seen in areas like procurement, production, and transportation. If companies keep excess inventory, they can take advantage of economies of scale by procuring, producing, and transporting goods in larger quantities than what is necessarily needed at the time. By handling material in bigger batches, quantities of goods, companies can divide fixed costs over more goods, thereby lowering the total cost. For instance, when ordering material or starting up production there are fixed order costs tied to the administrative part of ordering and fixed setup costs related to time and resources for setting up a production line. By ordering in bigger batches and producing with fewer production setups, the overall cost is decreased.

If a company faces seasonal demand, i.e. a high demand at certain times of the year, a company may choose to pursue a chase demand strategy where the goal is to carry little to none inventory and produce the exact quantities needed when the demand arises. An opposite strategy to this would be to leverage the function of inventory by pursuing a level production strategy that allows for smooth production and low capacity changes. By planning to have a higher inflow of material than outflow, a surplus of inventory will be the result. This enables a company to maintain a constant production rate and build inventory over time to later deplete this inventory when demand starts to increase. This can be economically beneficial if the cost of holding inventory is cheaper than the cost of changing production capacity.

Apart from the benefits stated by Anupindi, et al., (2012) above, companies can use inventories for more reasons. More inventory enables a company to reduce their lead time and increase their delivery service to customers (Bonney, 1994). Lastly, carrying inventory can allow a company to co-ordinate a mixed order of items from a single supplier into a single delivery, thus reducing transportation costs (Mattson & Jonsson, 2009).

Inventory costs and drawbacks

Anupindi, et al., (2012) argue that even if carrying inventory can be beneficial, it can also be expensive from both a financial and operational point of view. If a company is carrying a large amount of inventory and the market demand for their product changes to a new product, the company can find themselves left with capital tied up in inventory without a demand. In this scenario two choices are possible. The first option is to scrap the work-in-process inventory and liquidate their obsolete inventory at low prices to start producing a new product. The other option for the company is to finish processing and selling all inventory before starting to produce the new desired product. By doing so the company accepts a delayed launch of the new desired product and thereby responds slower to the market. Both scenarios exemplify two types of costs: physical inventory holding cost and opportunity cost. A physical inventory holding cost refers to all costs associated with storing inventory. This can be a warehouse, insurance, heating, etc. When holding inventory, a company is unable to place those funds elsewhere. By doing this, a company takes on an opportunity cost as the funds could potentially have yielded a better return on another project (ibid).

Axsäter (2006) discusses that if an item with demand cannot be delivered, then a shortage cost can occur. This cost can be hard to estimate, but the costs are tied to the revenue lost from the sale and administration costs for backlogging the order. Furthermore, there are other drawbacks to carrying inventory. From a process standpoint, it ties up working capital and can add to the administrative

complexity of a company. Also, inventory takes up physical space and while being stored it can become obsolete through, for instance, external damages (Bonney, 1994).

Inventory strategies

Inman (1993) points out that inventory is not the cause of a problem, but the result. He implies that reducing inventory without addressing the underlying cause is counterproductive. A good inventory reduction strategy should then target the underlying cause that leads to unsatisfactory inventory in a supply chain.

Scott, et al., (2011) describe five inventory strategies that are based on the logic that inventory exists as a buffer in the decoupling point between upstream supplier activities and downstream customer demand. The five strategies are mapped in Figure 3.12 and described in Table 3.5. By choosing how to manufacture the product, a company can choose where to have its decoupling point between supply and demand. Keeping stock at different decoupling points can be beneficial for different market requirements and product characteristics (ibid).

Table 3.5. Description of inventory strategies. Source: (Scott, et al., 2011)

Inventory strategies	Description
1. Make-and-deliver-to-stock	Activities are designed to replenish stock which is kept at end consumers. When an order is received, stock is removed from finished goods. Typical in retail stores.
2. Make-to-stock	Similar to make and deliver to stock, but instead stock is kept more upstream for instance in a regional warehouse.
3. Assemble-to-order	No stock of finished goods are held. When an order is placed, the product is assembled and shipped. Typical for mass customization like computers.
4. Make-to-order	Stock is kept in raw material and once order is place, manufacturing starts. Allows for more tailored products like customized furniture.
5. Purchase-and-make-to-order	No stock is held. Once order is placed, design is planned, material is bought and manufacturing begins. Typical for shipbuilding.

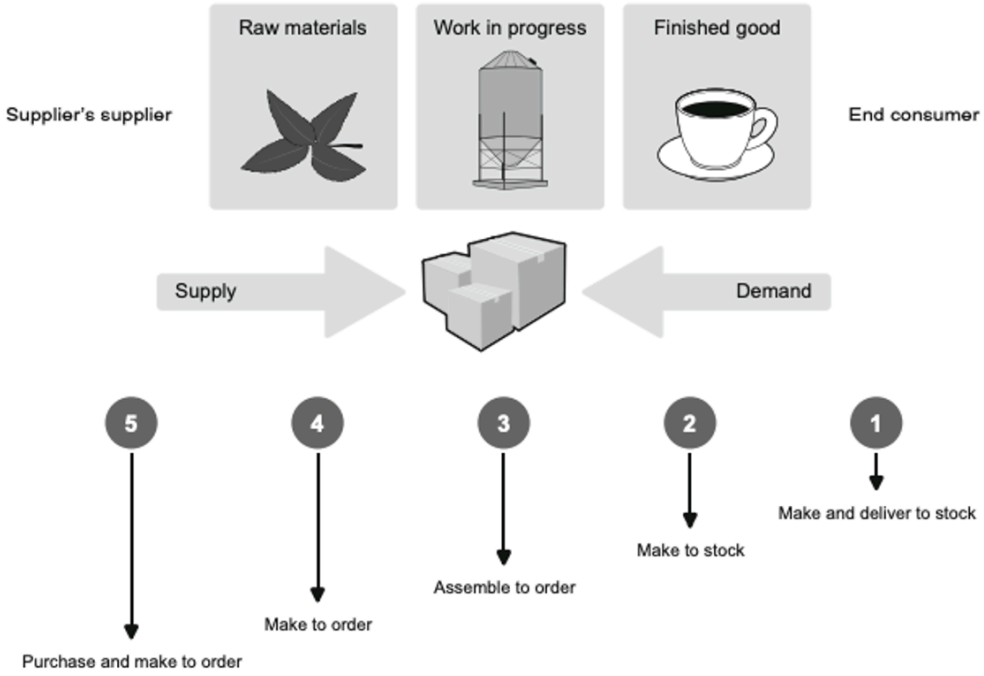

Figure 3.12. Inventory strategies. Source: (Scott, et al., 2011)

If certain customer requirements are new or too specific for a make-to-order, then a product can be engineer-to-order. Meaning that once the order is placed, the product is first developed and engineered before it can be built (Gunasekaran & Ngai, 2005), similar to a purchase-and-make-to-order. Scott, et al., (2011) state that a shorter lead time is enabled when the decoupling point is pushed downstream, and lower cost and better service is possible when the decoupling point is pushed upstream.

Anupindi, et al., (2012) mention that inventory can be reduced through postponement. This means that a process is reorganized so that the differentiation of a product specific to the end consumer is made at a later stage closer to the sale. By doing so customization is still possible and less inventory has to be kept for speculation and uncertainty. Chopra and Meindl (2013) argue that postponement is a good fit for companies that sell a large variety of products with an unpredictable demand across all products. The printer manufacturer Hewlett Packard famously faced an issue as customers in Europe and America had different power outlets. The printers were then redesigned in a more modularized manner that excluded the power outlet. The same modules were then distributed to the two markets where the distributors installed the power outlet depending on the market. By doing so, the company postponed its differentiation decision which made inventory planning easier (ibid). Huang and Li (2008) mention two postponement strategies, standardization, and modularization. Standardization is an approach that looks to replace two or more components for different products with a single component that fits different products and does not inhibit the functionality. This can allow for less component variation and lead time uncertainty. Modularization aims to organize complex products and processes into simpler sub-parts so that they can be managed independently while still operating as a whole. This allows any required combination to be assembled through a simpler assortment. This presents an opportunity for product design for economies of scale while still offering end customization product design (ibid). Figure 3.13 shows how modularization can enable postponement. Ulrich and Tung (1991) conclude that the benefits of modularization can be that a smaller set of components can be used to offer a bigger product variety and decrease lead time. However, this can also come at the cost of a static architecture due to the reuse of components.

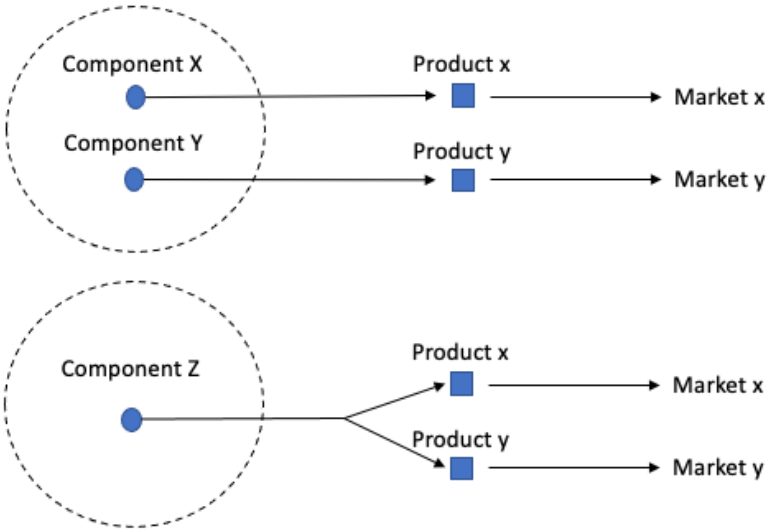

Figure 3.13. Illustration of postponement and modularization: Source: (Hsuan Mikkola & Skjott-Larsen, 2004)

Closs, et al., (2008) describe product portfolio as the total number of product configurations offered by a business at a given time. A complex product portfolio can enable more sales through competitive product differentiation, but it can also create supply and manufacturing difficulties. Closs, et al. (2010) studied the effect between unit fill rate, units filled as a fraction of units ordered, and product complexity and found that a higher product complexity decreases the unit fill rate for a given amount of inventory levels. This means that more inventory is needed to meet a certain unit fill rate if the product variety is more complex.

3.4 Strategy

This section aims to describe how strategies in organizations are structured, how generic strategies create a competitive advantage, and how supply chain strategies can affect business performance. This knowledge enables an understanding of how supply chain management links to an overall supply chain strategy and the strategy of a business.

3.4.1 Strategy in organizations

Bozarth and Handfield (2019) argue that a business is made up of structural and infrastructural elements. Structural elements are tangible resources like buildings and machines, while infrastructural elements are people, policies, rules, etc. A strategy is then how a business chooses to coordinate its resources of structural and infrastructural elements. Furthermore, Bozarth and Handfield (2019) define strategy in an organization through a top-down model, see Figure 3.14. In this model, a company defines its core values and reason for existence in its mission statement. Followingly, a business strategy is formulated which addresses time frames, objectives, and target customers for the business. The business strategy steers the operations and supply chain strategy and other functional strategies. Functional strategies refer to how a business strategy is translated to specific actions in function areas, like sales and finance. Operations and supply chain strategy define how structural and infrastructural elements will support the business strategy. It is important that the functional strategy and operations and supply chain strategy are aligned so they together support the business strategy (ibid).

Figure 3.14. Top-down strategy model. Source: (Bozarth & Handfield, 2019).

3.4.2 Competitive advantage

When it comes to strategy a company must establish what strategic positioning it seeks to attain. No matter the level, a strategy must contain choices, trade-offs, that differentiate them as no business process can perform well on every dimension (Anupindi, et al., 2012). Treacy and Wiersema (1995) claim that to become a market leader, a business must excel in one of three dimensions: Operational excellence, Product leader, and Customer intimacy. Furthermore, DeSmet (2021) has interpreted these dimensions for a strategy and supply chain context.

Operational excellence

The operational excellence strategy is focused on being the cheapest option while also providing easy services. The main idea of the strategy is to lower costs to offer a low price. This is generally done by optimizing the resources and costs that go into producing a product or a service so that there is no excess, thereby achieving operational excellence. However, there are some constraints. Even though the strategy aims to cut costs, there are parameters in the value proposition that are considered sensitive to the customer and cannot be jeopardized. As a result, the strategy aims to cut costs that are considered to add an overperformance dimension to the value proposition and instead deliver a simple product or service which only includes the basics, at the lowest price (ibid).

Product leader

The focus of a product leader is to provide the best product or service to their customers. By breeding innovative products and services with quality functions, customers can be attracted. Companies using this strategy gains a competitive advantage by offering a higher value than its competitors. However, providing this extra value comes at a price. Creating an exceptional product is costly and as a result, a product leader will charge a premium price for their products or services (ibid).

Customer intimacy

A company implementing a customer intimacy strategy succeeds by having customer knowledge and thereby providing a tailored solution to customer-specific challenges. By being excellent at helping and relieving customers of their current and future problems, they gain a competitive edge. Typical for customer intimacy is to offer a total solution, for instance, maintenance after the selling of a machine. With this strategy costs arise especially in the customer service part of the value offer, it is however also the reason why a customer intimacy strategy can be competitive (ibid).

3.4.3 Supply chain strategies

Fisher (1997) claims that a supply chain should be designed with respect to the product that it is going to supply. A product can either be functional or innovative depending on the demand characteristics. Demand characteristics create demand variability, where a functional product has a less volatile demand than an innovative product. Fisher's (1997) demand characteristics are shown in Table 3.6.

Table 3.6. Fisher's aspects of demand characteristics. Source: (Fisher, 1997)

Aspects of demand	Functional	Innovative
Product life cycle	>2 years	3 months to 1 year
Contribution margin	5% to 20%	20% to 60%
Product variety	Low (10 to 20 variants per category)	High (often millions of variants per category
Average margin of error in forecast at the time production is committed	10%	40% to 100%
Average stockout rate	1% to 2%	10% to 40%
Average forced end-of-season markdown	0%	10% to 25%
Lead time for make-to-order products	6 months to 1 year	1 day to 2 weeks

Furthermore, if the product aspects are functional or innovative, the respective supply chain should either be designed to be as physically efficient or market responsive as possible (Fisher, 1997). A supply chain can be characterized by its design regarding resource strategy, inventory strategy, and general objectives. Table 3.7 shows the purpose and strategy for designing a responsive or efficient supply chain. Research on the topic of linking product types and supply chain design has proven a significant relationship between the two and on the impact of alignment performance (Selldin & Olhager, 2007).

Table 3.7. Purpose and focus of a responsive and efficient supply chain. Source: (Fisher, 1997)

	Efficient supply chain	Responsive supply chain
Primary purpose	At lowest possible cost, supply predictable demand efficiently	Quickly respond to unpredictable demand to minimize stockouts, forced markdowns, and obsolete inventory
Manufacturing focus	Maintain a high average utilization rate	Use excess buffer capacity
Inventory strategy	Minimize inventory throughout the supply chain and achieve high inventory turnover	Have significant buffers of inventory
Lead time focus	Decrease lead time as long as it does not affect costs	Invest resources to decrease lead time
Selecting suppliers	Base decision on cost and quality	Base decision on speed, flexibility, and quality
Product design strategy	Maximize performance and minimize costs	Postpone product differentiation for as long as possible through modularization

In the context of supply chain strategy, Chopra and Meindl (2013) further argue that there is a zone of strategic fit which is shown in Figure 3.15. The zone of strategic fit shows how a responsive or efficient supply chain compares to uncertainty in demand. If the supply chain does not fit with the demand uncertainty, then it should be redesigned to improve performance and competitive advantage.

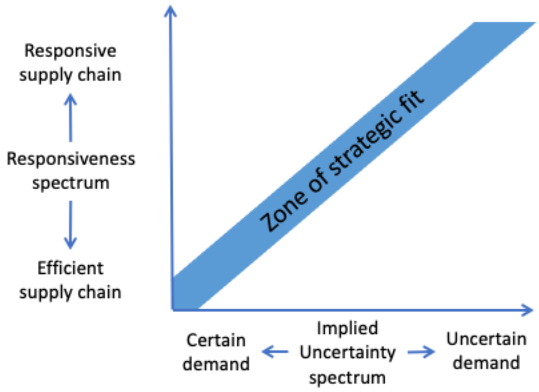

Figure 3.15. Zone of strategic fit. Source: (Chopra & Meindl, 2013)

Furthermore, Chopra and Meindl (2013) illustrate an efficient frontier which is the optimal boundary that companies can use when designing their supply chain. It shows how responsiveness is achieved at the expense of cost and vice versa. The relationship is illustrated in Figure 3.16.

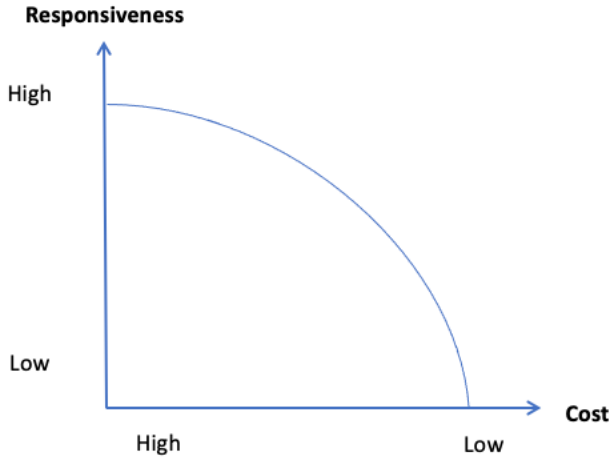

Figure 3.16. Efficient frontier. Source: (Chopra & Meindl, 2013)

Nakano (2020) argues that if a supply chain adopts an efficient strategy it should aim to improve its operational efficiency and use of assets. This means that a supply chain should be focused on increasing productivity in their production and logistics to reduce costs for these activities. On the other hand, a responsive strategy focuses on its ability to service the customer in the best way possible. This means that a supply chain should be designed so that it can adapt and meet varying customer demands with high accuracy. Furthermore, Nakano (2020) explains that supply chain management can address how to improve efficiency or responsiveness to enable an overall performance through four aims. This relationship is shown in Figure 3.17.

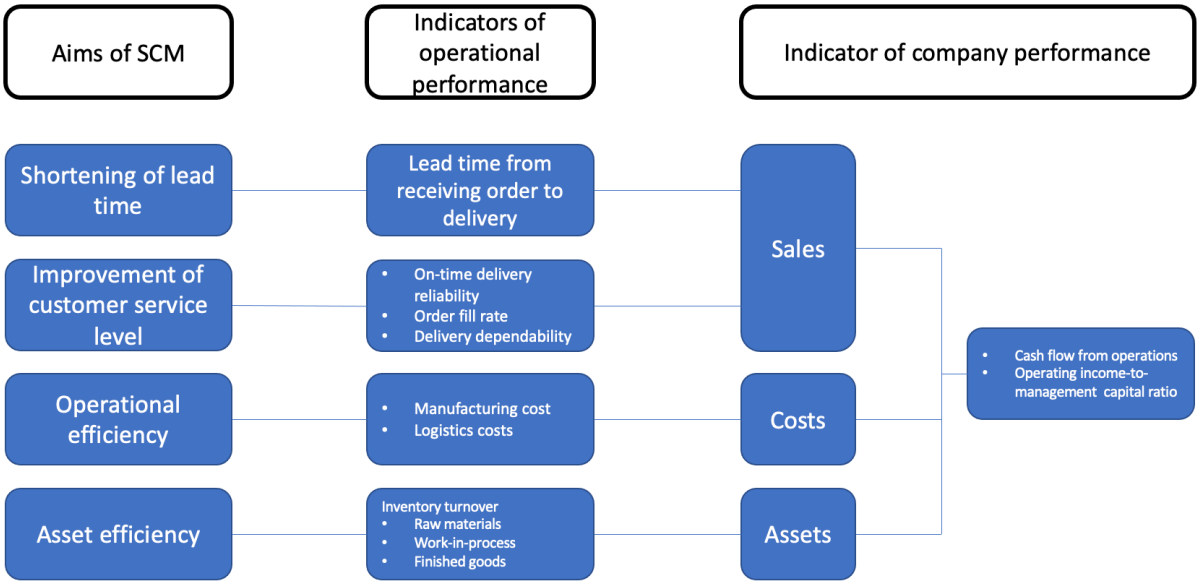

Figure 3.17. Aims of supply chain management. Source: (Nakano, 2020)

3.4.4 Improving performance

The four aims that Nakano (2020) mentions are shortening lead times, improving customer service levels, structuring for efficient operations, and use of assets. With these, a company can improve certain performance factors of a business. However, all these aims cannot be pursued at once as they can counteract one another due to the trade-off between efficiency and responsiveness. Consequently, a company needs to decide on specific aims to improve (ibid). Measures that help companies evaluate their performance are often referred to as KPIs. These can be especially important when it comes to making strategic decisions (Rachad, et al., 2017).

Lead time

Nakano (2020) claims that one of the four aims of supply chain management is to shorten lead time, the time between order receipt to delivery. Figure 3.18 exemplifies sub-processes that can make out a total lead time. Simply put, lead time is a measurement of speed, and it affects service level. Christopher (2000) makes a distinction between two types of lead time, speed, and agility. Speed focuses on the ability to meet customer demand while agility is more focused on being responsive to changes in customer demand. Stalk (1988) state that lead time has been recognized by many researchers as a competitive advantage, especially in the manufacturing industry. Furthermore, the author claims that many manufacturing companies have long lead times which forces them to plan for a long-term forecast. This is inevitably hard, and the accuracy of the long-term forecast is low. As a result, more inventory has to be kept and capacity plans lead to costly errors. A lead time reduction strategy should focus on increasing the speed of throughput, not total lead time (Tersine & Hummingbird, 1995). A shorter lead time from suppliers often comes at a cost due to premium charges or expensive modal of transportation (Chandra & Grabis, 2008). In terms of operations and manufacturing, minimizing cycle time and manufacturing lead time can reduce lead time. However, it comes at a cost (Bozarth & Handfield, 2019).

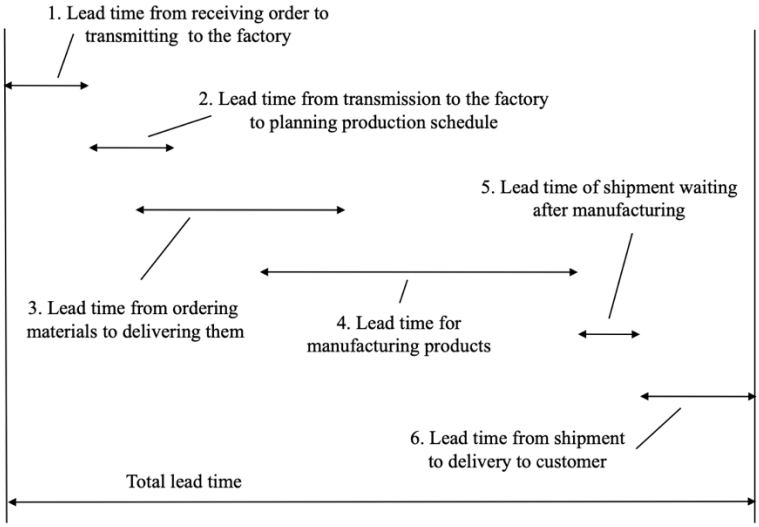

Figure 3.18. Example of sub-processes adding up to total lead time. Source: (Nakano, 2020)

Service level

According to Bozarth and Handfield (2019), service level is a term used to indicate how much demand can be met with inventory levels under uncertain demand and supply conditions. It is a measurement of customer service and product availability. Service level is correlated with safety stock. This is because the safety stock works as a constraint for what service level is achievable with a given safety stock. Much research has shown that a higher service level enables higher customer satisfaction which ultimately affects sales, thereby increasing revenue (Ballou, 2006). Chopra and Meindl (2013) state that the trade-off is that a high service level allows for a high level of responsiveness towards customer orders, but it increases inventory holding costs. A low service level decreases holding costs but leads to a larger share of customers not being served. However, offering an exceptionally high service level requires a supply chain to be able to meet a higher percentage of demand. This can become costly as rare surges in demand uncertainty might happen, although the underlying demand for a product might not change. If a customer does not get their order fulfilled due to unavailability they might go elsewhere (Chopra & Meindl, 2013). Rachad et al. (2017) state that a service level can be raised through three actions: improve the reliability of forecasts, review supply policies, and resize safety stock.

Operational efficiency

Nakano (2020) claims that a manufacturing company can increase its operational efficiency by increasing utilization and lowering the cost of operations. Chopra and Meindl (2013) explain that utilization is the fraction of capacity used in a facility. Having a higher utilization will enable economies of scale and a lower cost per unit produced as downtime and indirect costs will be better utilized, thereby achieving higher productivity. For instance, larger batch sizes and longer production runs will increase utilization and decrease the cost of production and cost per unit. However, it does so at the cost of creating more inventory and being less flexible and responsive. On the contrary, having smaller batch sizes decrease utilization and increase the cost per unit, but it also enables production to be flexible and change production for another demanded product. In short, there is a trade-off in operational efficiency (ibid). Furthermore, purchasing and material costs can vary depending on the size of the batches ordered. If larger batches are purchased, operations will be able to have an efficient production but at the cost of holding more inventory and vice versa (DeSmet, 2021).

Asset efficiency

Nakano (2020) explains that asset efficiency is an important performance indicator as companies do not want to hold more inventory than necessary. Inventory turnover is a measurement that indicates how much of the inventory a company is using. It shows the rate at which inventory is being sold, used, or replaced during a specific time frame, usually years (Rachad, et al., 2017). By having a high inventory turnover, companies attain a high asset efficiency as they minimize holding costs of inventory and tied up assets. However, a high asset efficiency can also imply that too little inventory is kept which hinders a company from being responsive and able to deliver orders (Chopra & Meindl, 2013). Important in achieving asset efficiency is understanding to what extent inventory is demanded and dimensioning inflow so that no excess inventory is being held (Nakano, 2020). Inventory turnover can be increased by eliminating excess items, reviewing, and changing the classification of stocked items, and reducing quantities ordered (Rachad, et al., 2017).

3.4.5 The supply chain triangle

DeSmet (2021) argues that the essence of supply chain management is about finding a strategy that balances what level of service a company delivers, at what operational costs, with how much cash (tied up assets). Figure 3.19 shows the supply chain triangle, which captures the three categories service, cash, and cost in an inter-dependent framework.

DeSmet (2021) claims that by trying to pursue all three categories at once in the triangle, tension will be created due to the inter-dependency of cash, service, and cost. The relationship between the three can be affected by many factors. To exemplify the relationship, if a company tries to raise productivity in manufacturing, the utilization of material and equipment might rise, thereby lowering cost per unit. However, this leads to more finished products and more tied up capital in assets, resulting in a lowered availability of cash (Johnson & Templar, 2011). If a company instead tries to fill every order to increase service levels and indirectly revenue, manufacturing will be forced to be more flexible and cost per unit will rise. Also, raising the service level requires more inventory which leads to less cash available. Finally, if a company decides to free up cash by reducing inventory, then fewer orders can be filled, and service and revenue will drop. Less inventory might also cause manufacturing utilization to decrease, causing cost per unit to increase (DeSmet, 2021).

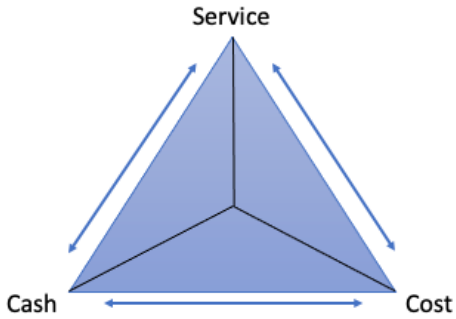

Figure 3.19. The supply chain triangle. Source: (DeSmet, 2021).

Based on this inter-dependency between service, cash, and cost, DeSmet (2021) argues for the importance of balancing the triangle. This means that there needs to be a strategy in place that steers coordination to accept trade-offs to gain a competitive advantage. DeSmet (2021) illustrates how the generic business strategies: product leader, operational excellence, and customer intimacy fit into the triangle. He does so by defining the axes as: service (premium of service), inventory turnover (tied up cash), and cost (R&D and selling, general, and administrative (S&GA), and general costs inquired).

To pursue a product leader strategy, a company needs to accept that a superior product and high margins require more costs for R&D, SG&A, and more. A product leader strategy also implicates complex products which often create higher inventory turnover. An “operational excellence” strategy will have a lower gross margin per product but instead focus on cutting costs of operations. High inventory turns are also more feasible due to simple products. Lastly, a customer excellence strategy is seen as a hybrid between “product leader” and “operational excellence”. Figure 3.20 illustrates this relationship (ibid).

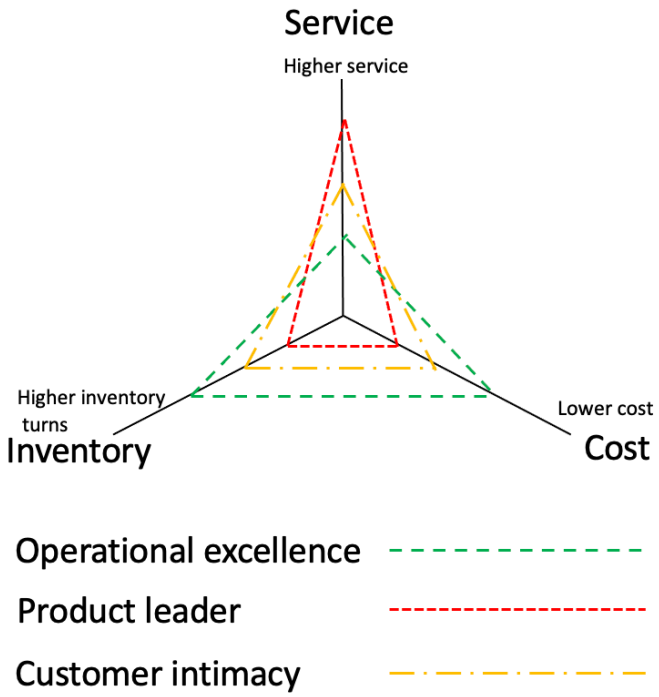

Figure 3.20. Business strategies in the supply chain triangle. Source: (DeSmet, 2021).

3.5 Organizational collaboration

This section aims to analyze how functions in an organizational setting can affect each other, but also discuss the difficulties of collaborating. The organizational collaboration topic is studied by looking at the individual desires of functions and the dependency between them in a manufacturing company, how “silo-thinking” can inhibit collaboration, and examining supply chain discontent.

3.5.1 Inter-functional scope

Chopra and Meindl (2013) discuss that the scope of different functions in a company can have conflicting objectives. As this can be hurtful to overall company performance, it is important to expand the scope across functions and align specific functional strategies to maximize the total profit of the company. DeSmet (2021) argues that in a typical manufacturing company, there are generally five functions that make out a functional organization: production, purchasing, supply chain, sales, and finance. Followingly, it will be examined how these functions typically relate to and affect one another in an operative setting. Figure 3.21 shows the relevant functions and their relationship.

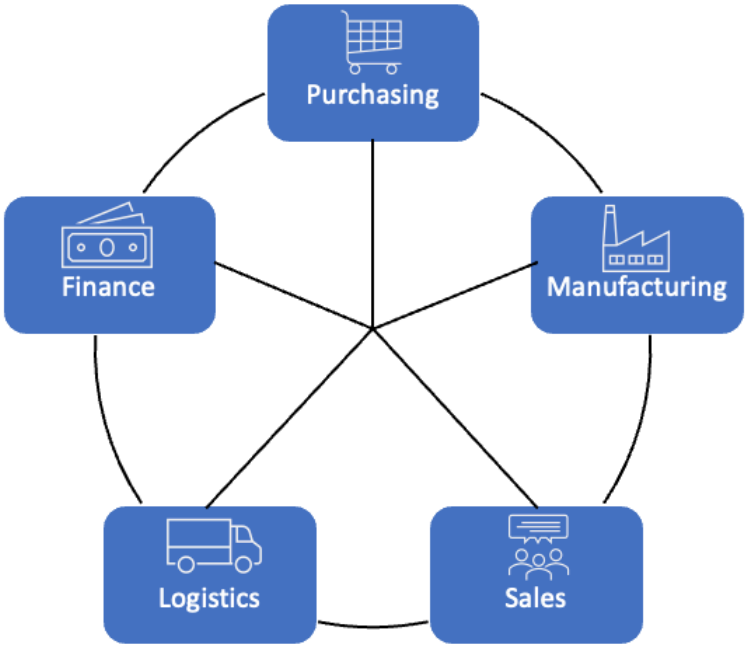

Figure 3.21. Relationship of general functions in a manufacturing company. Created by authors.

Purchasing

The purchasing function's main responsibility is to choose reliable suppliers who can deliver quality goods, on time, at a competitive price. Additionally, the function controls the procurement process which also includes issuing and following up on orders (Toomey, 2000). In general, a purchasing function is centered around procuring material, and therefore focusing on how much money is spent. One of purchasing's goals is to minimize spending and this can affect inventory and operations. Purchasing may choose to commit more to a certain supplier to get lower prices on their orders. Even if this may decrease their cost, it exposes the company to a risk of being dependent on one supplier. If this supplier would be unable to deliver, that could cause a shortage of inventory and thereby disrupt production. Another way of lowering purchasing costs is by increasing batch sizes, i.e. the volume of quantities ordered. This affects inventory levels as the material will arrive in larger quantities. Furthermore, the lead time and delivery accuracy may affect the price of purchasing. Variation and inaccuracy of delivery can make it harder to plan and execute operations (DeSmet, 2021).

Sales

The goal of the sales function is generally to sell as many products as possible. In other words, increase a company's revenue and market share. As a result, the sales function is keen to have a large inventory and flexible operations so that it can be responsive to market demands and cover any chance for a sale. In its nature, the sales function is more customer service oriented which implies that it desires other functions to adapt to their needs and changes (DeSmet, 2021).

Finance

The finance function controls the financial resources of a company and thereby dictates investments to achieve profits. For a product to be sourced and delivered to a customer, investments are needed throughout operations. Inventory is listed on a balance sheet as an asset because it is under ownership by a company. If material is processed into a finished good, it is considered valuable assets that can serve the customer. However, if there is more inventory than needed to meet the intended purpose, such as a safety stock, the inventory is considered excessive and a liability. If the inventory is regarded as a liability, then the money invested in this inventory could be used elsewhere, for instance, in product development, process improvement, or debt reduction (Toomey, 2000). Inventory alone can

account for 30% of a manufacturing company's invested capital (ibid). Because of this, a finance function is highly concerned with the amount of inventory that is being kept. Generally, a finance function strives to minimize investment tied up in stock (Mukopi, 2015). Furthermore, investments can be made in terms of the capacity of operations. For instance, hiring workers, building machines, and transportation. Change in capacity affects the cost of operations (Bozarth & Handfield, 2019).

Manufacturing

The main responsibility of the manufacturing function is to plan and steer the movement of goods through the production process, ultimately transforming an input into an output. Because of this responsibility, the manufacturing function performs activities such as planning, scheduling, and controlling of raw materials (Toomey, 2000). As the function controls general production, being efficient is crucial. If production is not efficient, costs will increase. More specifically, this often leads to a focus on reducing cost per unit which can be achieved through long production runs and few changeovers. By having a smooth and foreseeable production with few changes and small setup costs, efficiency can be attained. This means that manufacturing wants no overflow of inventory and little variation in what type of inventory it holds, while also not having more capacity than needed (DeSmet, 2021).

Logistics

The logistics function can have more than one responsibility. Usually, the function is responsible for handling finished products going from the company to the customer, but also managing inventory on a global level. Because of this, the function can have varying goals and therefore different desires. When it comes to handling inbound and outbound products, the goal is generally to decrease logistics costs. This can be achieved by having less inventory stored in a warehouse and fewer, but bigger transports. However, when it comes to managing inventory on a global level, the function is more concerned with freeing up cash. This can be done in a few ways. By reducing the product portfolio, cash is made available. Also, reducing production in general and the amount of minimum order quantity batches enables cash to be freed up (DeSmet, 2021).

3.5.2 Organizational collaboration

Rummler and Brache (1991) claim that various functions in a company sometimes view themselves as separate "companies" and treat other functions within the same company as their customers, thereby neglecting the real customers. This behavior of prioritizing self-interests, instead of the organization's interests, can lead to "silos" where functions oppose cross-functional collaboration which inhibits organizational processes. Rummler and Brache (1991) define the term "white spaces" as referring to the gap between functions that arise with "silo-thinking" and little cross-functional communication in an organization. "White spaces" between functions are illustrated in Figure 3.22. The authors suggest some solutions for addressing the "white space" and becoming more cross-functionally process driven, one of them being to establish common incentives. By creating common goals, functions are given incentives to work together which promotes collaboration to serve the customers rather than other functions. One way of promoting cross-functional collaboration and integration is through measurements, KPIs, which reflect the contribution of more than just one process (ibid). In context to Rummler and Brache (1991), Swink and Schoenherr (2014) presented a study that showed how cross-functional integration has positive effects on the efficiency and profitability of processes related to generating a return on sales and cost of sold products.

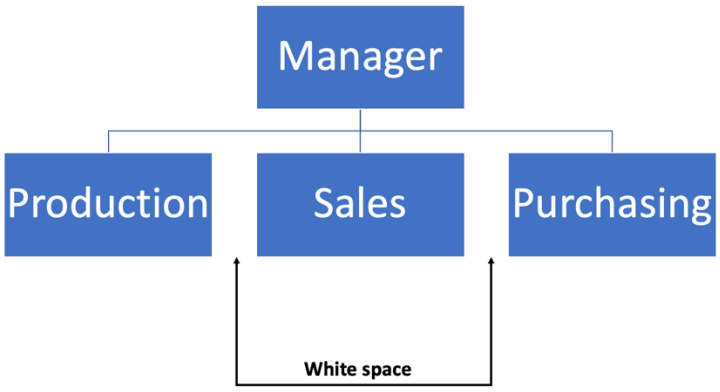

Figure 3.22. Illustration of white spaces in an organizational chart. Created by authors.

3.5.3 Supply chain discontent

Simatupang and Sridharan (2005) discuss the topic of supply chain discontent by analyzing types of discontent behavior, sources of discontent, and antidotes for discontent. A supply chain discontent occurs when two or three parties work together and perceive an organizational setting differently which affects their ability to perform. Actions taken by one member might be beneficial for them, but disadvantageous for others. Supply chain discontents leads to overall inefficiencies like excess inventory, high logistic costs, and more. With the framework presented in Table 3.8, Simatupang and Sridharan (2005) show how concern for one's own and others' interests can lead to an interaction that creates discontent behavior.

Table 3.8. Behavior styles of supply chain discontent. Source: (Simatupang & Sridharan, 2005)

		Concern for other's interest	
		Low	**High**
Concern for own interest	**Low**	**Avoidance** (We both lose)	**Forbearance** (I lose, you win)
	High	**Rivalry** (I win, you lose)	**Compromise** (We both win a bit and lose a bit)

Followingly, Simatupang and Sridharan (2005) describe six different sources of supply chain discontent which are necessary to identify to ultimately resolve the discontent. The authors then continue to provide six respective antidotes for each specific source of discontent. These are shown and described in Table 3.9.

Table 3.9. Sources of supply chain discontent. Source: (Simatupang & Sridharan, 2005)

Source of supply chain discontent	Description	Antidotes
Incongruence	When members have different opinions on strategic objectives to reach competitiveness	Mutual strategic objectives
Disintegration	When performance measures are based on individual measures isolated from the entire goal	Appropriate performance measurements
Misrepresentation	When there are differences in decision making which lead to counterproductive decision	Decision synchronization
Distortion	When there is an information asymmetry which creates a hidden agenda	Information sharing
Misalignment	When rewards or punishments does not optimize the whole	Incentive alignment
Fragmentation	When processes contribute to various wastes along the supply chain	System thinking

3.6 Analytical framework

To conclude the frame of reference, Figure 3.23 illustrates how the theory in the frame of reference chapter concludes relevant literature and how it will be used to address the purpose and research questions of this thesis. Furthermore, it shows how the empirical data will be structured and how all the content contributes to addressing the scope of the thesis.

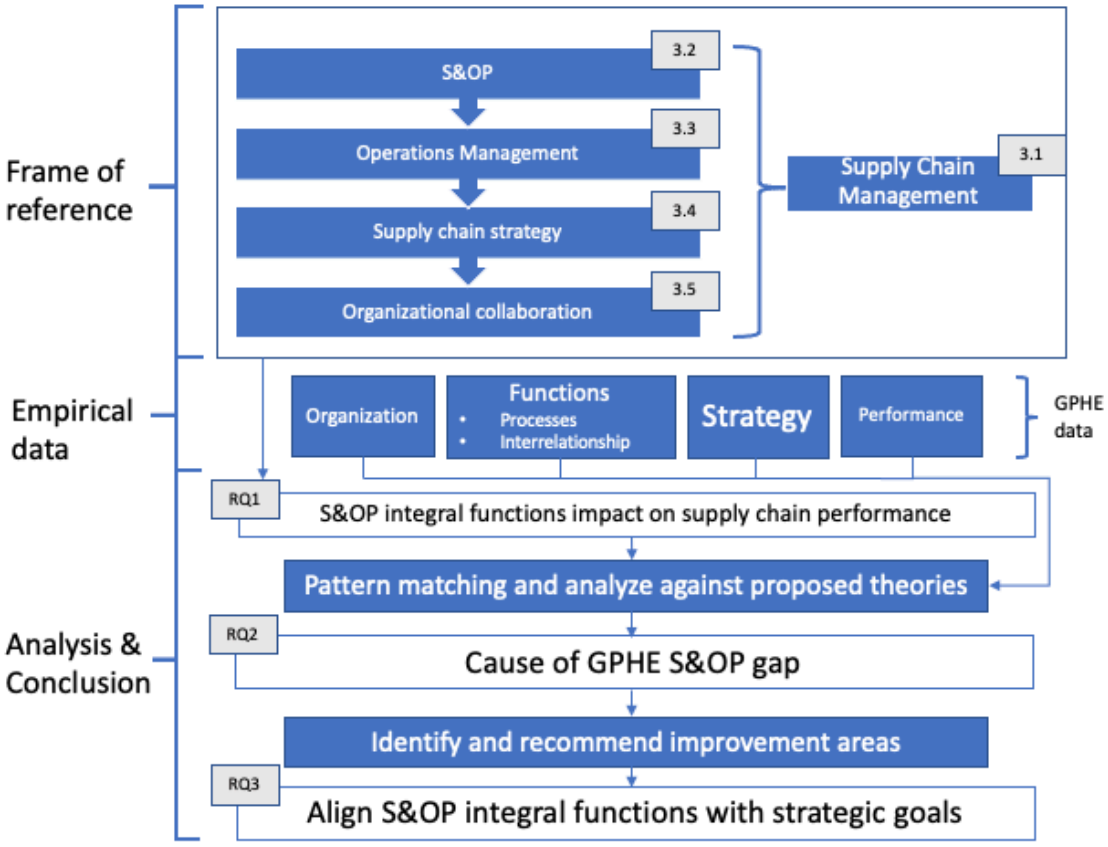

Figure 3.23. Conceptual illustration for thesis analysis model. Created by authors.

4 Empirical data

The empirical data was gathered at Alfa Laval through interviews and observations. This chapter has summarized this information and presented it in a structure that highlights how the organization is structured, how the S&OP process is adopted, which the integral functions of S&OP are, how these functions work outside S&OP, what the strategies of the functions and the business unit are, and what problems exist.

4.1 Products and customers

Alfa Laval GPHE manufactures gasketed plate heat exchangers. Figure 4.1 shows how the products can look. The main function of the product is that it enables heat exchange from one source, for example liquid and gas, to another source. The heat exchange function of the product can be used in heating, recovery heating, cooling, condensation, and evaporation. These applications are desired in industries mainly concerned with refrigeration, heating, ventilation, air conditioning, engine cooling, chemical processing, oil production, power generation, and food. GPHE invests a lot in R&D and continuously develops and launches new products. Products are generally assembled-on-order and configurated after the customer's specification or engineered-on-order specifically for customers. As a result, there are many product variations to meet the various tailored demands of customers. Depending on the product, the lead time can vary from a couple of days up to several years. In general, GPHE's products are considered to be of premium standard with functions that are considered exceptional in performance. The product life cycle is long and can in some cases be up to more than 50 years.

Figure 4.1. GPHE products. Source: (Alfa Laval, 2023)

4.2 Organizational structure

At Alfa Laval, three main business divisions reside under the top management. The business unit GPHE belongs to the energy business division. GPHE can, according to the employees at Alfa Laval, be considered an affiliated company as it operates independently in many ways. The business unit mandates how products are developed, marketed, managed, serviced, sold, and supplied. In general, covering the major functions that enable the business unit to operate. Especially important for this thesis is the function called "Product Group GPHE" (PG GPHE), highlighted in Figure 4.2.

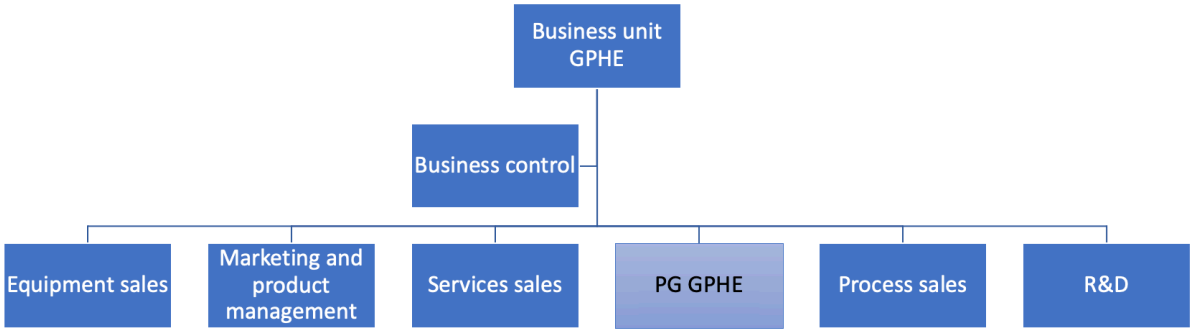

Figure 4.2. Structure of the GPHE business unit and its functions.

The product group GPHE function is globally responsible for manufacturing and supplying the products. This is not to be confused with the business unit that has responsibility for the products, but also for the functions necessary to support development, sales, services, etc. for the products. Central for the product group is that it has responsibility for the three GCC factories and the seven LA factories. To support these factories in their production, the product group has functions, shown in Figure 4.3 which on a global level manage the factories.

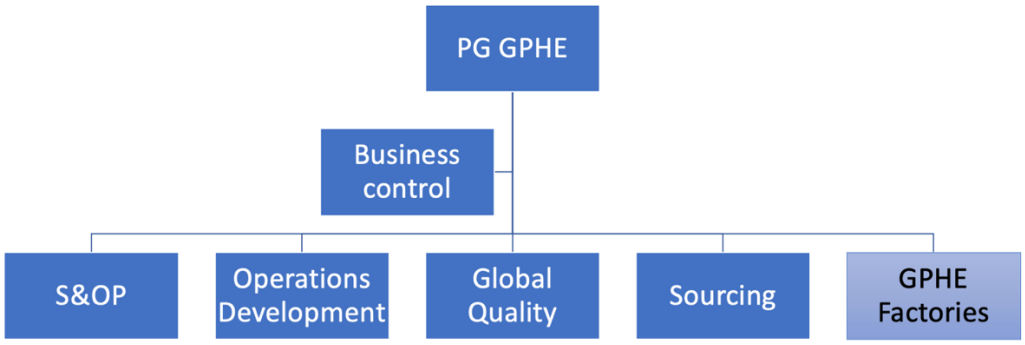

Figure 4.3. Product group GPHE organizational hierarchy.

The relationship between the functions in the product group and the factories is illustrated in Figure 4.4. The relationship can best be described as each factory being viewed as a single company. The factories coordinate their own manufacturing and provide for the product group and indirectly the business unit. The functions in the product group share the responsibility to coordinate all the factories on a global scale so that their aggregate capacity is fully utilized. Even though the individual factories have local operations, they are managed in a centralized manner so that a global aspect is taken into account. The product group functions support the factories' operations by providing and developing policies, plans, systems, and procedures for how to execute their operations. In the context of the S&OP and the business unit, all factories are considered "operations". By handling operations on an aggregate level, total capacity and supply can be estimated. The total output of the operations is what the business unit can supply market demand with. Present in Figure 4.4 is the sales function. They can be viewed as customers to the factories as they place orders on what they want, and indirectly the real customers.

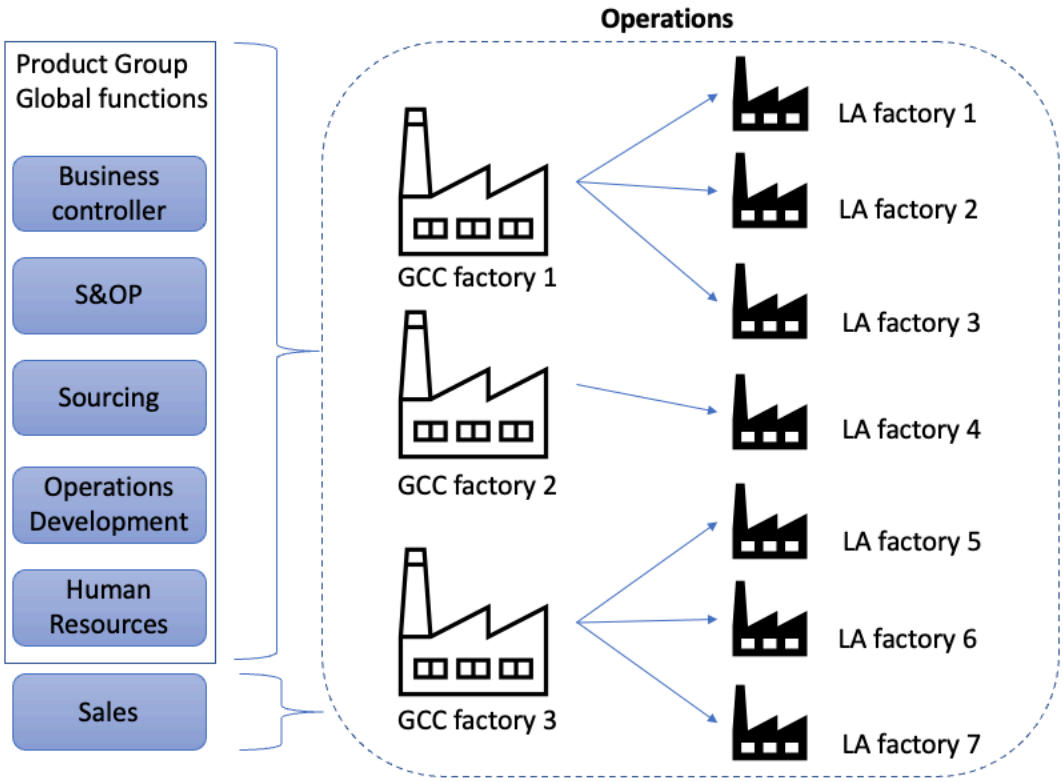

Figure 4.4. Illustrative example of the global relationship between factories and global functions. Created by authors.

4.3 S&OP at GPHE

Alfa Laval have implemented a S&OP process that is adopted to their current needs. Their process starts with Product portfolio planning, followed by demand planning, supply planning, balancing and decision making, and execution. How Alfa Laval GPHE have chosen to adopt the S&OP process and how they are working with the different steps will be discussed in the following subchapters.

4.3.1 The S&OP Business function

The S&OP business function at Alfa Laval is relatively new, as the process was implemented in the organization only four years ago in 2019. One of the main responsibilities of the function is to ensure that the process is operating optimally, while continuously trying to find potential improvements. They act as a hub in the middle of the process where they work to facilitate its iterations. The function can be described as primarily an administrative function that has ownership of the process and is responsible for facilitating cross-functional collaboration. They enable the different participating business functions to come to a consensus by moderating the S&OP meetings and are from there responsible for the rollout and implementation of the resulting plans.

The overall commitment for the business function is to deliver one final S&OP plan that is transparent on what risks and opportunities it has considered. They are making sure that the final plan is communicated and executed. This is achieved by participating and supporting all the different phases in the S&OP iteration.

With the role of being a hub for the S&OP stakeholders and providing the forum in which collaboration is facilitated, the key enabler for the function to operate properly is good lines of communication. Without it, they would be very constrained. The benefit that many business functions speak of with the S&OP implementation is that it provides transparency throughout the business unit of GPHE. No function can gain an advantage from withholding information and the responsibility for the entire BU's

success and failure is shared and celebrated mutually among the stakeholders. Any chance of potential finger-pointing or blaming other functions if something does not go according to plan have been abolished.

Figure 4.5. Alfa Laval's five planning phases. Source: Alfa Laval.

4.3.2 Product portfolio planning

The five main process steps and their respective process steps are illustrated in Figure 4.6. For GPHE, the S&OP cycle starts with product portfolio planning, which is a phase hosted by the S&OP manager. In this phase, the focus is to analyze the current portfolio. They investigate what products there is a market demand for, that should be developed, and if there are any products that should potentially be phased out. This is done by collecting and reviewing data, tracking performance versus projections, and using this information to update the forecasts from the previous iterations.

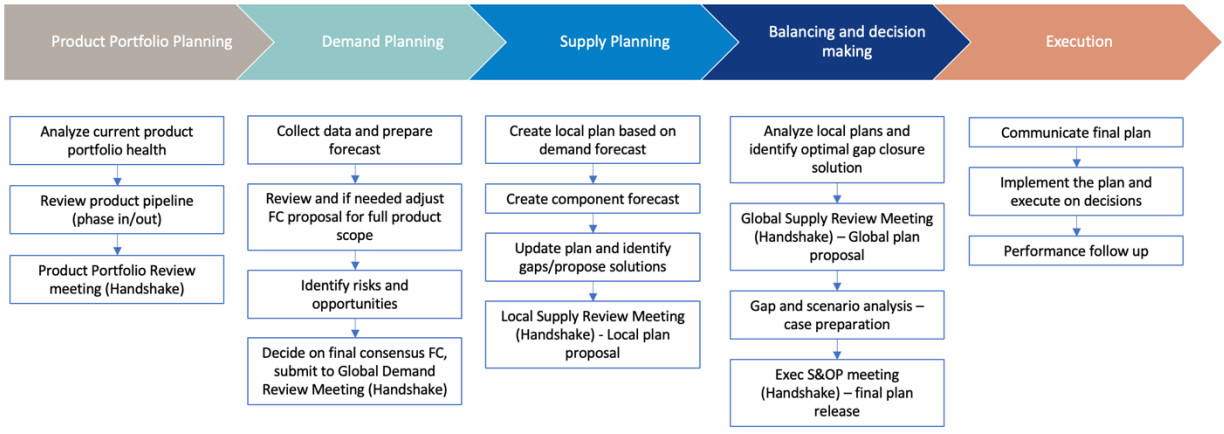

Figure 4.6. The five S&OP phases and key subtasks. Source: Alfa Laval.

After this preparatory work is completed, the product portfolio planning phase ends with a formal meeting. The meeting is organized by the product management team with participants from supply planning, operations, finance, sourcing and demand planning, and S&OP management. Here they work on a set agenda taking the prepared product review data and discussing its contents. They analyze KPI's to understand how the previous period performed and the accuracy of the forecasts. Furthermore, they discuss any major changes in assortment, sales, or sourcing, and the potential risks,

issues, and opportunities moving forward. The output from this meeting contains agreed volumes on certain products, potential adjustments that should be included in the following steps of creating the demand and supply plans, and finally a list of actions, risks, and decisions that were agreed upon in the meeting. All this information is entered into an information software which is used to generate forecasts in the demand planning phase.

4.3.3 Demand planning

The demand planning phase of the S&OP process is crucial for how well GPHE's process will work. In this phase the sales organization collects market data and uses the portfolio review information, among other dimensions, to prepare a forecast on how much that potentially can be sold throughout the organization. This forecast is generated using an advanced forecasting system. The forecast is completely unconstrained by internal factors such as what can be produced. Instead, it only considers the market demands and how much of this market the sales team can satisfy. Risks and opportunities are identified and used to review and potentially adjust the input parameters that generate the forecast.

Similarly to the product portfolio phase, the demand planning phase is completed through a formal meeting, called the demand review meeting. In this meeting, the participating demand planner, sales, product management, controller, and S&OP manager, take input from the demand overview created in the forecasting software, KPIs, information on opportunities and market requirements and product introductions, etc. This information becomes the base for discussions on the sales pipeline, phase-in and out volumes, and the demand numbers for the following 4-18 months. The output and purpose of the meeting is that the participating stakeholders agree on the forecasted volumes that are demanded by the market. After the BU signs off on the unconstrained forecast it is delivered to operations.

4.3.4 Supply planning

In the third step of the iteration, the factory managers, factory planners, sourcing and purchase planners are tasked with taking the demand plans for the previous step and translating them into a supply plan. In this phase, the team works together to create a plan that takes the demand numbers and tries to see how much of that can be met with what the production facilities are capable of supplying. They also formulate a list of actions and decisions that needs to be taken moving forward, such as equipment investments or staffing. Each site has a formal local supply review meeting where they review the local component supply, capacity, and inventory plan for the following 4-15 months. They also create a list of scenarios and options, and all this information is collected and forwarded to the next step in the supply planning phase, the global supply review meeting.

4.3.5 Balancing and decision making

The balancing and decision-making phase of the S&OP iteration consists of two primary steps. The global supply review meeting and the executive S&OP meeting. The output is one final S&OP plan that is aligned and agreed on by all the different stakeholders in the business unit.

The global supply review meeting consists of the Product Group (PG) manager, PG controller, PG supply planner, factory managers, and the S&OP manager. Their task in this forum is to discuss the information from the local supply review meetings and use it to create a holistic supply plan. This plan considers what the entire organization can supply in the determined time horizon. Focus lies on gaps, potential risks, and issues that can affect the entire organization in any way. They discuss and analyze all the previously created scenarios and recommendations. Finally, they agree on volumes that are to be presented and recommended in the executive meeting.

The executive S&OP meeting is the final decision-making forum for the S&OP process iteration. It contains the PG, BU, and S&OP managers, the BU sales managers, the BU product manager, and the PG Supply planner. Here they review the cases and scenarios to agree on the final S&OP plan, sign off on it and commit to the inevitable risk it might induce.

4.3.6 Execution

Execution is the last step of the iteration. It is here that the plan is communicated to the operative roles to make sure that everybody is pulling in the same direction. The plan is delivered to the production facilities so that they can plan on increases or reductions in capacity, purchasing is made aware of their volumes and sales on how much they should sell. Other actions and decisions that have been agreed on during the iteration, i.e., potential equipment purchases or employee hires, are executed. Following this, much attention is given to performance follow-up where the different teams are collecting data on progress and plan adherence, etc. Other data such as market changes or production rates are also collected and used in the next iteration.

4.3.7 Other S&OP findings at Alfa Laval GPHE

When the S&OP process at Alfa Laval was first initiated, it was an initiative from the operations development department. It was implemented to increase the sense of shared responsibility for the BU at large and concurrently also reduce the white spaces between functions. A large campaign was undertaken to convince management, executives, and colleagues of the potential gain that could be obtained from its implementation. While the value-adding benefits that the process has brought are acknowledged across all business functions, there are mentions of areas in the process that are lacking.

Trust in the process

Respondents have mentioned that one area where S&OP is lacking is in the discussions on how certain data or scenarios are prepared, in a way that potentially illustrates a lack of confidence and trust in the process. There is a lack of assertiveness to the scenarios and cases that are presented which are demonstrated by discussions taking place i.e., on how data is obtained, rather than how it will affect the organization. This has resulted in discussions in the executive meetings regarding questions in time horizons longer, or shorter, than the intended scope of the meetings. Which causes the considerations to either be too detailed, or generalized, to bring the most value. Resultingly, the output decided plan is not totally absolute in the way that it should consider every scenario and its effect. Furthermore, this allows for doubts to emerge when the plans are delivered down the organization. These doubts could affect the level of commitment the receiving party has to adhere to these plans. This can then be observed by the purchasing department not committing to buying the full quantity of a component that the plans suggest, e.g., only buying 80% of the planned quantity. Or by factory planners not hiring new staff according to the suggested required man-hours. Essentially, the reports have shown that while actions are taken on the S&OP plans, there is a lack of executing them to their full extent.

Knowledge

Another issue or area of potential improvement suggested during the data collection at Alfa Laval is the general lack of knowledge and competence about S&OP. Both that of employees directly involved in the process and of those indirectly affected by its performance. The lack of knowledge possessed by the direct stakeholders of the S&OP process are said to hinder the ability to interpret the plans or scenarios, make assumptions and draw conclusions from them. Examples have been described where the use of data to address needs or changes was faulty due to a lack of experience. It is the perception of some S&OP participants that an increased experience and competence in all the directly involved business functions would potentially also increase the sense of assertiveness that plays a major part in the scenario analysis and final decision-making. If neither executive managers nor operations are

completely convinced that the plans are feasible to achieve, there is a natural lack of willingness to go the extra mile trying to execute them. Furthermore, interviewees mention that if knowledge on the process is increased throughout the organization it will result in an increased encouragement to adhere to the outputs. That information should be shared on what value the process adds to the organization, the scenarios that are considered in the iterations, and how the decisions that are taken affect various functions. Finally, some respondents speak of a lack of initiatives to address process development, instead most of the efforts directed towards the S&OP process is in the form of only maintaining the process.

4.4 Processes of integral functions of the S&OP

This section aims to highlight the main responsibilities, processes, and collaborations that the integral functions of S&OP have. In the S&OP, sales, product management, operations, and sourcing all have responsibilities regarding forecasting demand, reviewing products, and supplying capacity. Figure 4.7 shows how these functions are present within the business unit.

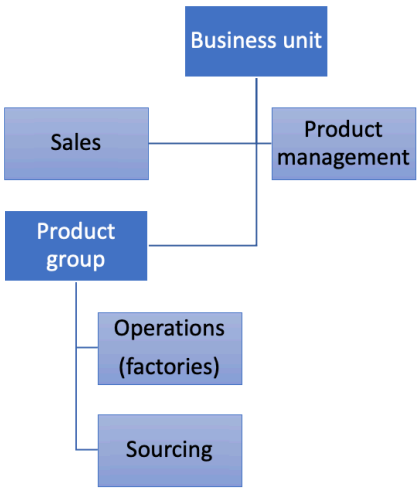

Figure 4.7. Sales, product management, operations, and sourcing in the business unit. Created by authors.

4.4.1 Sourcing

At Alfa Laval, there is a global sourcing group where each business unit is represented through a sourcing function. Present in this group is GPHE's sourcing function. The sourcing function for GPHE has overall responsibility for ensuring that the collaboration between GPHE's site purchasing at each factory and their respective suppliers is done in a way that is aligned with the strategy and goals set by the global sourcing group and GPHE.

For all three levels of sourcing, global sourcing, GPHE sourcing, and site purchasing, there is a level of mandate. If the sourcing concerns a global supplier that is supplying to more than one site, then the global sourcing group is responsible for dealing with that supplier. If a sourcing concerns a supplier only used for one site, then the GPHE sourcing function has the responsibility for managing that relationship. The site purchasing functions at each factory can in some cases handle suppliers on a local level. No matter who is responsible for the relationship with the supplier, the local site purchasing function at each factory executes the actual transaction and orders of supplies. Figure 4.8 shows this relationship and highlights GPHE sourcing which is present in the S&OP.

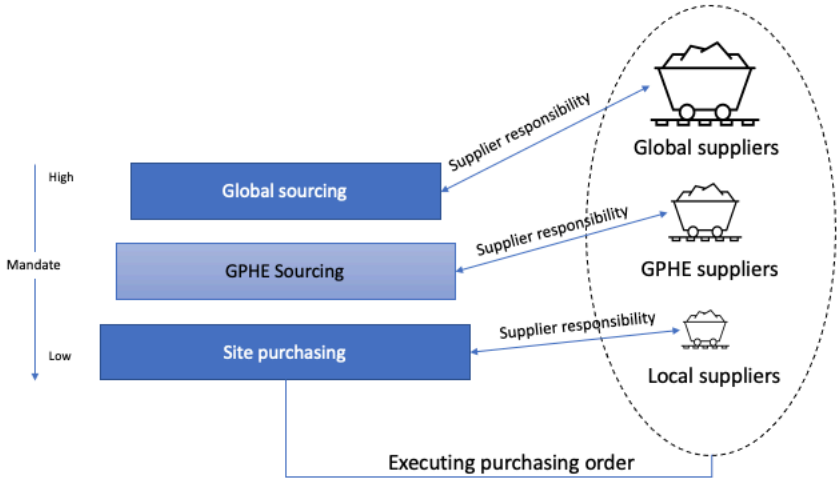

Figure 4.8. Sourcing hierarchy and responsibility. Created by authors.

The main responsibility can be considered as having two objectives: sourcing competitively and strategically. Sourcing competitively refers to a set of requirements that the global and GPHE sourcing teams has set. These requirements include everything from socially sustainable aspects to lead time demands. The GPHE sourcing team's responsibility then becomes to make sure that the suppliers are complying with these demands and support the local site purchasing functions for optimization. For instance, ordering quantities so that inventory is kept at an optimal level. The input from S&OP becomes an important factor in sourcing competitively as the GPHE sourcing team must make sure that decisions in the S&OP reach local functions and that they perform after set targets. Furthermore, the GPHE sourcing function works in a strategic manner, meaning that they collaborate with GPHE functions like product management, sales, and R&D for future and special product projects that will need material and equipment. This process enables sourcing to secure the availability of material and equipment ahead of manufacturing so that there is an infrastructure of suppliers in place to support new product launches or special projects.

4.4.2 Sales

The sales operations in Alfa Laval GPHE are divided into three subcategories, all dedicated to their own customer segment or industry. The three are: Process sales (PS), Equipment sales (ES) and Service sales (SS). Each of them responsible for their own category and sales figures. This means that they can sell heat exchange products for more than just the energy division, even though they operate in the GPHE BU. This division allows them to work horizontally across business units, while also maintaining and developing knowledge of the salespersons as they can narrow down and focus on fewer industries. The sales organization in Alfa Laval GPHE is managed centrally at the HQ, with a local presence from local sales offices. The local sales offices are globally spread out across markets and serve all business units. They work rather independently as they are not tied to GPHE specifically, instead, they sell all the products and services provided by Alfa Laval depending on customer requests. Especially important with PS and ES is that they work closely with product management and provide inputs from customers so that functionalities of products are developed in line with market demands. Service sales provide aftermarket services and are not within the scope of this thesis.

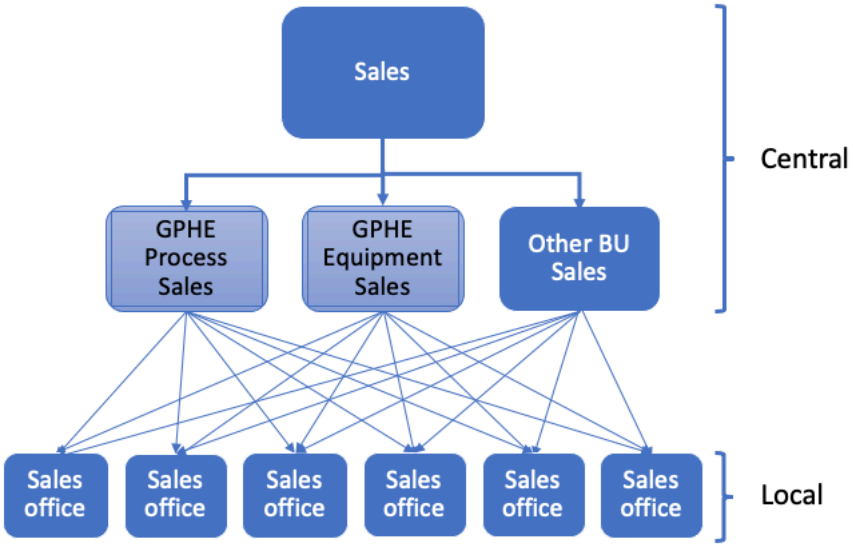

Figure 4.9. Illustration of sales organization. Created by authors.

Process Sales

PS is a sales function in Alfa Laval that targets customers within process industries, chemicals manufacturing, nuclear, oil, gas, and hydrogen to mention some. The PS team operates in a wide range of areas within the organization to ensure targets and strategy. Some of them are for example sourcing, S&OP, and assortment control. By doing so, they can e.g., align capacity with demand to secure product availability through S&OP, source components competitively, and fortify and develop products for their market among other initiatives.

Process sales offer their customers two different product categories, make-to-order and engineer-to-order. Either they offer their customers their expertise by assisting in specifying and dimensioning existing products based on the needs of the customers in a make-to-order setting. Examples of such can be the size of the product, the number of plates, or the pressure that the product should be certified for. Following this, the customer is presented with a suggestion and upon agreeing, the order gets placed in the production queue. The other option is handled by a subdivision called Project Sales. Project sales is a team devoted to accommodating orders where there are special requirements on the product, engineer-to-order. The orders require entire project groups to solve problems or develop current products. In this team, the limitations are close to none. Whether the customer wants a different color on the product or more innovative solutions to complex problems, there is a team of engineers, designers, and operators that work to accommodate any potential wishes. However, this of course comes at a cost, both monetary and at additional lead time.

Equipment Sales

ES is responsible for selling heat exchangers used for heating, cooling, and re-heating which are used in cities, buildings, or data centers for example. As with PS, ES does not only sell products but also forwards the market input to the product management function so that products are continuously developed in line with market demand. Furthermore, at the time of launch, they support the market introduction. The products are, in contrast to PS, less tailored and more standardized and components are used across product groups. As a result, ES contributes to the majority of GPHE's sold volume. The products have shorter lead times than the process sales, but also smaller margins. It should be noted that the standardization is relative and that producing and selling a heat exchanger is a complex task.

4.4.3 Operations

Operations are the producing business function at Alfa Laval GPHE, meaning all the factories. Even if all the factories represent separate entities with local functions, they are bundled together as a large function that is managed on an overall level by the product group. On a day-to-day level, operations manage everything from purchasing materials to producing the products and delivering them to the customer. The product group and its global functions help manage and develop operations so that they can produce and deliver to customers. This means that operations are coordinated on an aggregate level so that capacity is spread out and utilized globally to leverage operations to be able to meet demand. Figure 4.10 illustrates local functions within a factory and operations' relationship to global functions.

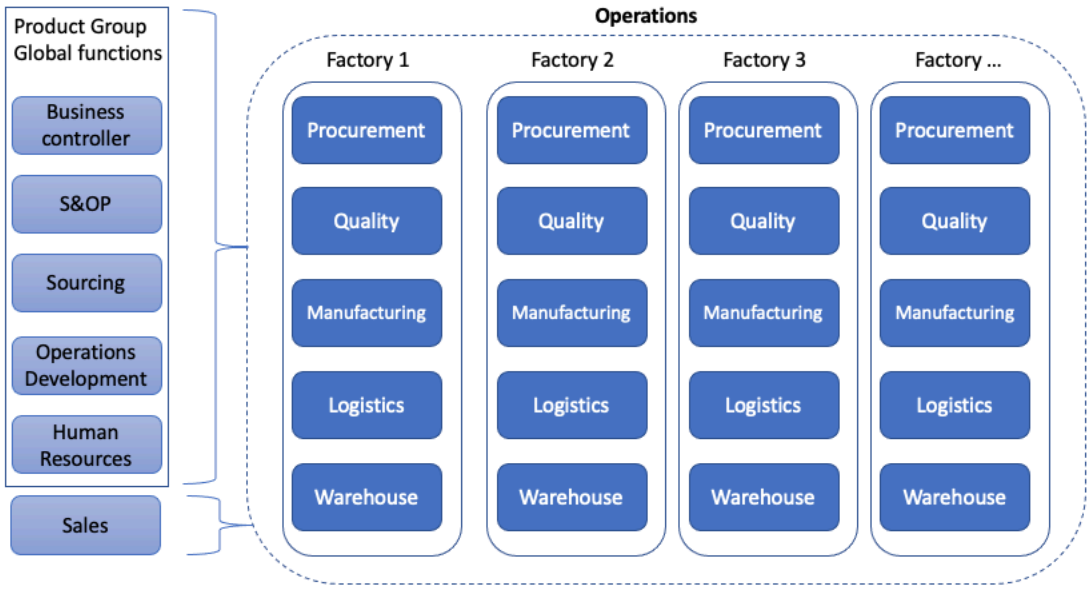

Figure 4.10. Local functions within factories and operations. Created by authors.

There are two types of factories in operation, GCC and LA. GCC is set up to have equipment and processes to refine raw material into components. These components are made to stock based on forecasted demand and once requested shipped to LA. LA factories are globally more spread out to have a local presence on the market. They have a setup that is focused on assembling components and parts into final products. They have an assemble-to-order system, where they order components and parts from GCC and external suppliers. Keeping them in stock and assemble them once an order is received. It then directly goes out to the customer and no finished goods are stored. This relationship is shown in Figure 4.11. As a result, inventory is held in GCC as raw materials, work in progress, and semi-finished goods (plates and components). In LA, inventory is held as semi-finished goods of plates and components, as well as inventory that is assembled, work-in-progress.

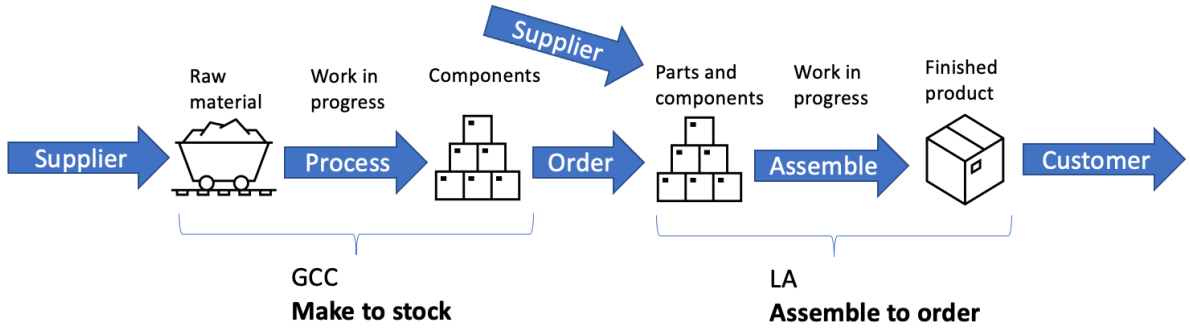

Figure 4.11. Operations manufacturing and assemble process. Created by authors.

When planning the output of the factories, there are production planners and factory planners that consider a short operational time horizon where they plan daily and monthly outputs. They ensure the delivery of materials so that the various processes are running smoothly and consider other short-term factors that can affect production. On time horizons that are 4-18 months, they work to translate S&OP production plans into actual production numbers. They retrieve and interpret the S&OP plans agreed upon in executive meetings, from there translating the general data and figures into implications for different shifts, process steps, purchasing, and other areas. On even longer time horizons, they also work with the operations development department on how the output or throughput of the production sites can be improved. This can be achieved either through large-scale changes such as investments in new equipment or redesigning the factory layout, or through smaller ones such as changes to processes or technology.

Another important activity of operations is collecting and presenting data, such as output volumes, purchasing quantities, etc. To support these activities, there are financial controllers stationed locally at every production site reporting back to the central management. These reports are essential in providing data and history for S&OP plans. Additionally, the financial controllers assist in ensuring that all production sites operate using the same processes, collecting data the same way, working towards the same KPIs, and reporting in a timely manner.

4.4.4 Product management

The product management function's main responsibility is the ownership of products. This includes developing, launching, and phasing out products. Furthermore, the function has responsibility for the process of controlling what assortment should be kept to enable product variation, and how to price these. The product management function can be described as a moderator between sales, R&D, and operations where they bridge the gap between what the market wants, functions to develop, and how to make products. Figure 4.12 illustrates this relationship.

The development of an existing or new product starts with product management working closely with the sales function to get inputs from the market demand. These inputs are derived from the changing market demand which creates a gap between what functionalities existing products offer and what the market wants. The product management identifies these requests for product development and creates a product project which clarifies the specifications the new product should have and defines what it should solve. This is done in close collaboration with the R&D function. Furthermore, product management also conducts a cost-benefit case where the function works together with operations and sales to understand the feasibility, costs for manufacturing, and the expected demand of the changes. Finally, the launch of a new or changing existing products is decided upon by executives from R&D, product management, and operations. From there, the product is developed until it is ready to be manufactured and sold. Once a product is at its launching phase, product management works

closely with sales to get the product on the market in the best way possible. Lastly, in the process of developing new products, product management also collaborates with operations development to develop production processes parallel with products for efficiency.

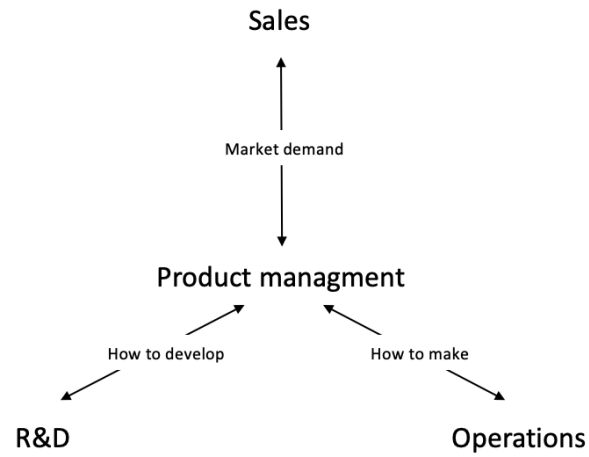

Figure 4.12. Product managements functional coordination.

Existing products are continuously reviewed in terms of demand. Because of the many configurations that gasketed plate heat exchangers can have, many parts are needed, and many variations exist. Therefore, product management also works with assortment control. This process is integrated into the first step of the S&OP, where planning on assortment is discussed and decided upon. Product management continuously works with inventory and analyzes what assortment is moving (demanded), what is slow moving or obsolete (little demand), and what should be terminated (no demand). With specific guidelines, the assortment is monitored and categorized regarding demand, value, and need.

4.5 Strategy and objectives

This section looks to clarify what the individual and common goals are for the GPHE BU, S&OP, and its integral functions. Furthermore, it also highlights experienced difficulties in these goals.

4.5.1 Business unit

The strategy for the business unit includes three goals:

- The #1 heat transfer service company
- The #1 experience for all customers
- The #1 in a transforming energy market

The BU aims at being the number one service company when it comes to providing services before, during, and after a sale has been made. For GPHE, being the number one service company means that the BU wants to be seen as a partner to customers rather than just a provider of products and services. A large part of this strategy is to offer a total service that covers maintenance throughout the product life cycle. However, this is considered outside the scope of the thesis. The total solution includes that the BU provides a competitive value proposition. Meaning that each sold gasketed plate heat exchanger should be specifically tailored and configured to customers' specific needs.

The goal of being the number one experience for all customers means that the BU wants to provide a product and a solution that is superior and outperforming in terms of functionality. Furthermore, the experience should include the availability and flexibility of products. By providing that, the BU offers

a quality solution. The BU measures this goal by aiming to be the market leader in terms of number of units sold in all countries.

The strategy of being a leader in transforming the energy market is focused on sustainability. GPHE places a high priority on providing energy efficient solutions to their customers. Apart from the business point of view, Alfa Laval and GPHE looks to be a leader in providing decarbonization applications for heating, cooling, electricity, chemicals, and fuels.

The business unit measures performance in many ways, but there are six KPIs for the business which are shown and described in Table 4.1. These are considered guiding indicators for GPHE to pursue its business strategy.

Table 4.1. Business unit KPIs.

KPI	Description
Market leadership (%)	Indicator of size of market share.
Growth (%)	Indicator of growth of revenue. Affected by price of product and number of products sold.
Return on Capital Employed - ROCE (%)	Indicator of the profitability relatively to the amount capital employed.
Operating income - OP inc (SEK)	Indicator of profitability
Return on Sales - ROS (%)	Indicator of how efficiently a company generates profits from sales.
Operating Working Capital - OWC (SEK)	Indicator of efficiency as it measures the amount of resources and assets needed to fund a company's operations.

The business strategy shows that GPHE monitors the market in terms of changes in market share as well as revenue growth. Furthermore, the business unit measures its profitability, both total and relative. Lastly, the company also measures operating working capital. The point of this measurement is to understand how much assets are needed for day-to-day operations. The reason for this is to monitor the performance so that the BU is not using an excessive amount of capital when pursuing its business strategy.

To summarize, the business unit looks to be the biggest provider of gasketed plate heat exchangers on the market. The offering should include a tailored product with exceptional functionalities and a partnership experience. With this goal stated, GPHE wants to provide this service while being as asset efficient as possible.

Product management

From a strategy point of view, the product management function prioritizes creating a product that is a market leader in terms of functionality. By working closely with sales to understand the market and R&D to develop products around its needs, the function strives to deliver innovative products that outperform competitors. For each specific product, a wide assortment of components follows as the strategy of providing a tailored solution requires the product to be able to be configured differently depending on the customers' desires. As a solution to this, the products have historically been designed around a base of standardized components that can be put together with different components to provide customization. Modularization has not been explored too much and is something that is currently being investigated.

The product management team claims that they are aware of the many KPIs and goals set by the business unit, but the amount of KPIs creates white noise and confusion due to the lack of

prioritization. However, the most important KPIs for the product management function have been the "Conversion rate" and "New product development". GPHE has historically developed and updated its product lines of gasketed plate heat exchangers. However, at the launch of an updated product line which was supposed to replace the old product line the company had a hard time trying to stop selling old products and only selling the new product. In the most recent example, GPHE developed a product line called "M-series" that was launched in the 80s. In 2017, the "T-series" was developed to replace the outdated M-series. The T-series has the same application as the M-series, only with better functionalities. Product management has been prioritizing getting the new product line T-series developed and launched, while also converting from the old M-series to the new T-series. As it turns out, the function has been successful in their new product development and has introduced many products from their T-series. On the other hand, they have not had a good conversion rate and the phase-out of the M-series has been slow. Passivity has led to a situation where the M-series has not been scrapped and is still offered today. In context to this example, GPHE has still not been able to scrap product lines that are even older than the M-series. Due to the many configurations of each product, a new product launch carries a large assortment of components. As mentioned, this assortment must be kept available as long as the product is active and offered to customers.

Sales

The global sales strategy of Alfa Laval GPHE is to become the number one supplier of gasketed plate heat exchangers in the world and the first option for their customers. For PS and ES, this means that they aim to be the market leader in terms of market share and provide an exceptional product in terms of functionality but also a tailored solution. As a result, the sales functions pursue as many sales as possible and try to adjust to customer demands as much as possible to win an order. Both sales functions claim that they have a lot of freedom to operate if they generate more sales and thereby more growth. The functional strategy for the functions places emphasis on customer segmentation so that the right resources are used for the right customer and thereby providing a better service. Furthermore, the salespeople working centrally in the BU are incentivized on gross profit.

The local sales offices support more business units than just GPHE and do not report directly to the business unit. Their objective is still to provide the number one solution for their customers in terms of performance and support. The local sales offices are incentivized through commission to sell products with the highest margin. As they function independently and offer services to more BU's, they sell products that have the highest margin and fit best with each solution. Historically, this has led to sales of old products that the BU wants to phase out. The reason for this is partly that the salespeople know the older products better and their commission for selling them is this more profitable.

4.5.2 Product group

The objective of the product group is to be an extension of the BU that is aligned with the goals and strategy of the BU. The business strategy of the BU is translated into goals and objectives that should manage the central functions and operations. The strategy for the product group is to "Be perceived as #1 when it comes to time and quality". More specifically the objective of the product group is to enable high supply capability and source quality commodities for superior products. With this strategy, the product group focuses on supporting operations with resource allocation, so the capacity needed to meet demand is sufficient. The product group claims that it seeks to prioritize responsive performance attributes of the supply chain rather than cost-saving initiatives.

Operations

Even if operations consist of several factories globally spread out, they are still governed by the product group and its central functions. When it comes to strategy, operations are closely monitored in terms of capacity and demand. Proactively they keep track so that their capacity always can meet demand and furthermore take action to address upcoming capacity constraints. In terms of resources, operations invest in equipment and processes to improve performance in terms of cycle time and capacity. By doing so they enable a higher output, but also a shorter manufacturing time for a given unit. As capacity is modified to lead demand, so is inventory. Stock is measured in days of demand, instead of days of supply. This suggests that focus is placed on modifying supply to demand and proactively preparing inventory for upcoming demand. This is described as a mix between a chase and level strategy as operations partly increase capacity to chase unusual demand, but also prepare ahead and level out production over a longer time. The inventory strategy is to have safety stock, anticipation stock, and strategic stock so that service levels can be ensured, and manufacturing and deliveries executed in a scenario where external factors could disrupt the regular flow of material.

When it comes to long-term planning, operations are governed by a "Plan adherence" measurement. This means that each factory creates a supply plan that must be approved by S&OP and then judged by how well they follow it. Resources from the product group are also available if needed to meet this plan e.g., extra capacity. Ultimately, they are then judged depending on how close they adhere to the plan, and indirectly support the BU.

Currently, operations have an excess of inventory and a lower turnover than what they aim for. The inventory that is being referred to is raw material at GCC and components and plates both at GCC and LA. Parts of these inventory levels are considered to be excess as it totally amounts to more inventory than the planned sum of cycle stock, safety stock, strategic stock, pipeline stock, and anticipation stock. Because of this, the turnover of inventory is low at both GCC and LA and that leads to holding costs and opportunity costs. Furthermore, parts of the inventory that is being held have a low demand and are considered as obsolete and incorrect inventory.

Sourcing

The stated strategy for the sourcing function is "align capacity with demand to secure availability, competitiveness, and sustainability". One of the main aspects of the strategy is that of material specification, quality. The impact on quality is not considered in this thesis. However, it should be noted that Alfa Laval has some of the highest quality specifications on the market which excludes certain suppliers. The three other important aspects that suppliers are evaluated on are on-time delivery, variability in lead time, and cost. By prioritizing on-time delivery and stable lead times, suppliers are chosen who can provide material with high precision to make planning for material availability easier for local purchasers. Minimizing costs results in less money spent on purchasing. Furthermore, the sourcing strategy includes setting up a network of optional suppliers which are used if a short lead time is necessary, thereby securing an agile solution if needed. Altogether, suppliers are measured and evaluated after these parameters. This leads to a selection of suppliers which offer quality, delivery precision at a low cost, and agility if needed. The sourcing strategy also concerns sustainability topics that are outside the scope of the thesis.

S&OP

The overall strategy for S&OP is to align demands from sales and supply from operations to secure profitable growth. As the business strategy is to increase market share and customer service, the S&OP aims to support this plan while also balancing and preparing operations regarding long-term capacity. The goal for S&OP then becomes to steer for growth while still not jeopardizing delivery capabilities. This is monitored through four primary KPIs: plan adherence, forecast accuracy, delivery service level,

and inventory days of demand. Measuring forecast accuracy guides the function in the matter of understanding how well plans are executed, which enables the function to improve its control and balancing capabilities between demand and supply. Tracking inventory days of demand helps understand what the availability situation is so that future delivery and responsiveness can be ensured, but also so that costs of holding inventories are not increasing. Lastly, the delivery service level is a guiding factor for the responsive performance of operations. By using it as a guiding performance indicator, the focus is placed on capabilities to deliver orders to customers at a competitive level.

4.6 Issues and gaps

During the data collection, two major issues were expressed as concerns by multiple people. These major issues were seen as gaps between the plan and the outcome of the S&OP. Recurringly, the S&OP finds itself having to deal with these issues. The gaps are presented in Table 4.2 below.

Table 4.2. Description of major gaps between S&OP plan and outcome.

Gap	Description
Low inventory turnover	GPHE finds itself having inventory throughout operations that are considered excess, some of which are obsolete and incorrect. As a result, they have a lower turnover of inventory than they wish for. The volume of inventory ties up cash and inquiry costs. The S&OP has historically not focused on the topic of inventory, but now they have addressed that the turnover performance must improve.
Plan adherence	GPHE are unsuccessful in ensuring that the plans that are generated from S&OP and delivered to operations are successfully being followed. Their ability to guarantee that the short-term planning considers the long-term plans and execution towards fulfilling those plans is insufficient.

5 Analysis and evaluation

The analysis chapter looks to combine the knowledge from the literature review with the empirical data to provide an analysis that is in line with the research questions and the scope of the thesis. The analysis is based on matching patterns that are recorded in the empirical data and evaluating how this affects the perspective of the research questions.

5.1 Theoretical evaluation

To answer the question of how integral functions of the S&OP can affect supply chain performance, we begin by first stating what we define as integral functions. As the process looks to balance capacity and demand, it is a cross-functional process that considers inputs from several functions. Firstly, the sales function is an integral function as it represents demand from the market through actual orders and forecasted demand. The second integral function are operations. As operations are described as the people, technology, and systems in an organization that has responsibility for providing its products and services (Bozarth & Handfield, 2019) , it can include several functions. However, due to the high-level approach of this thesis and the context of GPHE, we view operations as a single entity that has responsibility for the manufacturing and managing inventory, storing. Thereby aggregating all processes with production and storing as one function. Thirdly, the sourcing function is considered an integral function of the S&OP as it has the responsibility of purchasing the material to enable production. Lastly, product management plays an integral part in the S&OP as it controls what products that are offered and how they are developed and designed. Because the S&OP demand forecast is based on the product assortment and the supply plan is affected by product design, its impact is vital for S&OP. Figure 5.1 illustrates S&OP's integral functions from an inter-functional and a supply chain perspective.

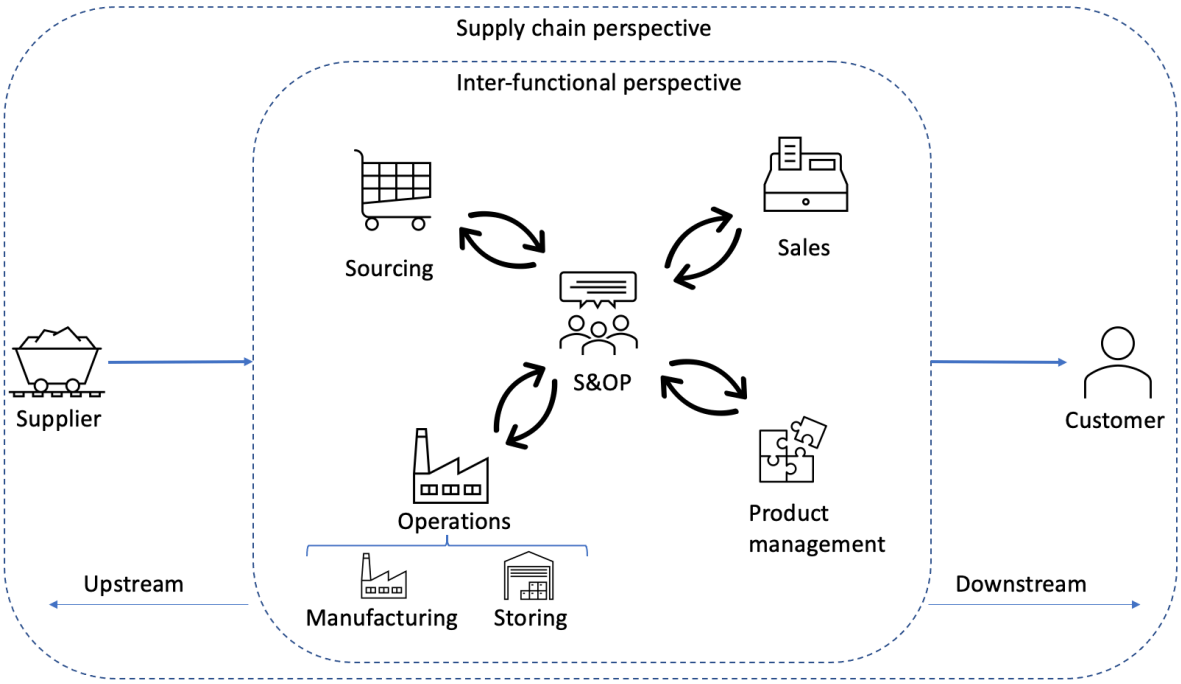

Figure 5.1. Inter-functional relationship and supply chain perspective. Created by authors.

A supply chain can be constructed in several ways with varying components. However, the performance of a supply chain is measured in two ways: efficiency and responsiveness (Fisher, 1997). To address RQ1, we will base our answer on supply chain performance impact after these two parameters, but also from the perspective of the supply chain triangle developed by DeSmet (2021).

5.1.1 Responsiveness

If a product is innovative and has an unpredictable demand, then its matching supply chain should be responsive (Chopra & Meindl, 2013). The objective of a responsive supply chain is to be able to respond quickly to unpredictable demand so that it can meet demand when it arises.

Sales

The sales function's impact on supply chain performance becomes more of a question of how to utilize the supply chain in the right way. With this logic, it can be argued that sales impact supply chain performance by aligning on what to do, rather than how to do it, to leverage the responsiveness of the supply chain in the right way. As the sales function's primary responsibility is to sell products to customers, they become restrained by upstream activities allowing them to meet the unpredictable demand. In a responsive supply chain, functions take on extra costs to be able to deliver an exceptional operational performance that becomes competitive instead of trying to minimize costs. For the function to be aligned with a responsive supply chain performance, it should strive to satisfy customers as much as possible. Flexibility is offered to the sales function mainly through low lead times and extra inventory that allows them to provide a higher service level that enables competitiveness. Followingly, this will lead to an increase in sales and revenue and indirectly market shares (Nakano, 2020). This type of aim has similarities with the idea of customer intimacy and product leadership (DeSmet, 2021). To be able to create value from the operational performance, the sales functions must make use of this supply chain capacity and adhere to customers to be able to meet and satisfy more demand than it could otherwise (Fisher, 1997). If the sales functions do not adhere to pursue sales and customer demand, the sales function will impact the supply chain to take on costs without leveraging the agility of the supply chain. For instance, dimensioning for extra capacity is costly, and if it is never used then no output improvement will be seen (Yu-Lee, 2002). Furthermore, if sales do not provide the service level that the supply chain is dimensioned for, inventory will be built up, leading to a lower inventory turnover rate and more holding costs (Chopra & Meindl, 2013; Nakano, 2020). Ultimately, not providing responsiveness can lead to costly imbalances. In short, the sales function impacts a responsive performance by pursuing and chasing demand and thereby utilizing the benefits of the supply chain. To use simple symbolism, a race car should be driven by a race car driver.

Operations

With the definition used in this thesis, the operations function can impact a responsive supply chain performance through manufacturing, inventory, and lead time. As demand can be uncertain, operations need to have the capacity to cover demand when it is high and should therefore try to lead capacity (Olhager, et al., 2001). Due to the long lead time of changing capacity, this implies that operations must carry excess capacity through lower demand times, ultimately decreasing utilization of capacity which increases the cost per unit. This can be considered a trade-off. However, by having excess capacity, operations can impact the supply chain to meet increased demand and ultimately higher sales (Olhager, et al., 2001; Ballou, 2006). In combination with extra capacity, operations must have the ability to carry extra inventory to be prepared to meet demand once it rises. Trying to achieve a higher service level will require more safety stock (Ballou, 2006). A higher safety stock will not only decrease inventory turnover and asset efficiency but also increase holding costs and opportunity costs which impacts operational efficiency (Nakano, 2020). Furthermore, inventory should be modified so that it is chasing demand, rather than leveling it (Olhager, et al., 2001). By doing so flexibility and availability will be ensured and a shorter lead time and a higher service level can be attained. Operations can impact a responsive performance in terms of lead time (Nakano, 2020). By having shorter production runs and being able to change production setup faster, the function can adapt and impact the flexibility of the supply chain performance. For operations to be able to impact a responsive performance it should invest in ways to reduce cycle time so that it can decrease the lead time of production and increase flexibility to produce demanded products (Bozarth & Handfield, 2019). However, by focusing on the responsive performance aspect of operations, economies of scale will not be utilized as much which leads to an increased cost per product. To summarize, by having excess

capacity, excess inventory, and flexible manufacturing, the operations function can impact the supply chain to be more responsive, however it comes at the cost of operational and asset efficiency.

Sourcing

This thesis does not consider some aspects that can expand sourcing's impact on responsive performance like quality. However, with the limitations of this thesis, the speed and flexibility of the sourcing of material do have an impact on responsive performance. By selecting suppliers based on their speed of delivery, the supply chain can shorten its lead time which impacts downstream activities and the supply chain to be able to adapt faster to demand once it arises (Fisher, 1997). Selecting suppliers based on speed does however come at a cost, which will increase the cost of purchasing (Chandra & Grabis, 2008). Furthermore, the topic of optimizing exact order volumes is considered too detailed for this thesis. However, sourcing should select suppliers so that supply is not constraining operations to chase demand and inventory to be kept in excess.

Product management

As the product management has ownership of the product, they become responsible for the design of the product which is something that can significantly impact supply chain performance (Fisher, 1997). By driving a design that makes use of modularization, the complexity of the assortment decreases and the assembly of the product that creates this differentiation can be postponed (Ulrich & Tung, 1991). This impacts the responsiveness of the supply chain as products can be assembled at a later stage in the supply chain and thereby increases the ability to act quickly upon customer order. Modularization also enables a scale of design as it offers customization, without tailoring each specific component of the assembly (Huang & Li, 2008). An innovative product that aligns with a responsive supply chain has a higher product variety (Fisher, 1997). It is partly this aspect that creates the uncertain demand which the responsiveness aims to capture. Consequently, the product variety creates a broad assortment of products. Even though this is necessary, it will lead to more inventory needed to be able to meet orders (Closs, et al., 2010). One risk that can follow when driving a modularization design strategy is that the reuse of components can create a static product architecture (Ulrich & Tung, 1991). Due to the importance of matching an innovative product with a responsive supply chain, this must be carefully considered so that the innovative demand aspects are not destroyed through product design.

In Figure 5.2 below, the main impacts that integral functions of S&OP can have on a responsive supply chain performance are summarized (for more details see Table 5.1). Through the supply chain triangle framework, an illustration is made of how choices available to the integral functions of S&OP can enable a supply chain to meet customer demands and provide higher service. It is also shown how an enhanced responsive performance comes at the expense of inventory and costs.

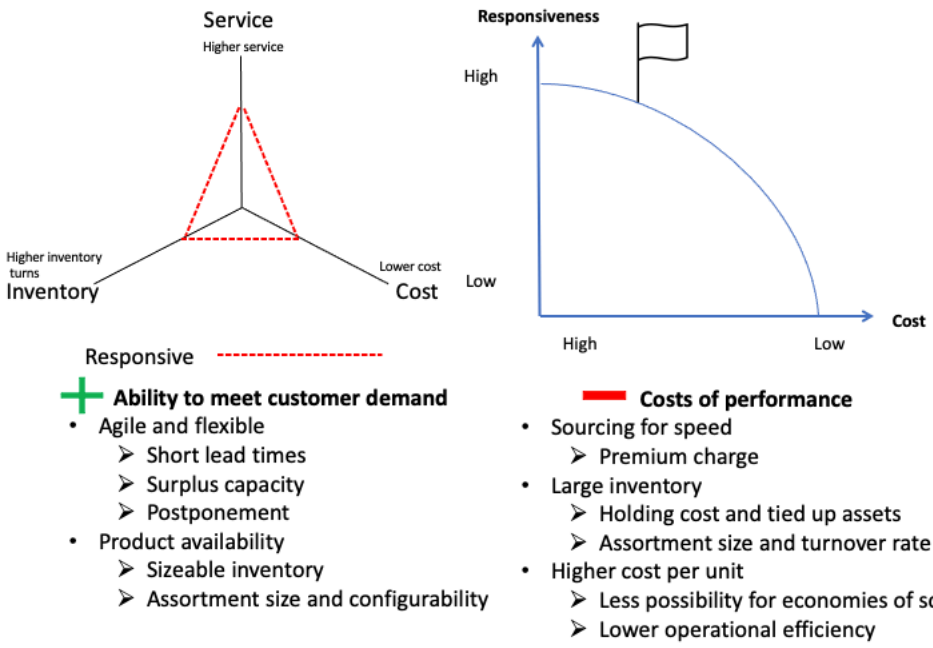

Figure 5.2. A responsive supply chain in the supply chain triangle framework. Created by authors.

5.1.2 Efficiency

An efficient supply chain is best suited for a functional product with less uncertainty in demand (Fisher, 1997). Due to the predictableness of the demand, the supply chain can focus on being as efficient as possible when trying to meet said demand. This implies that the supply chain should minimize costs as much as possible while still being able to meet certain demand (Chopra & Meindl, 2013).

Sales

Sales impact on an efficient supply chain becomes a question of prioritization and what not to do. As the organization embodies the idea of cutting costs and providing a functional product, sales must also do the same. To do so, sales should advocate the idea of a simple product and not try to configure it after each customer's demand (DeSmet, 2021). Instead, the focus should be on setting an acceptable service level that captures the predictable demand and provides availability to that extent (Chopra & Meindl, 2013). By doing so the function is aligned with the goals of the upstream activities and allows them to focus on creating internal optimization and consequently obtain an efficiently performing supply chain. If the sales function would target unpredictable demand, that would instead create imbalances for upstream activities in terms of capacity and supply as they are not dimensioned for it (Chopra & Meindl, 2013). This could further jeopardize the supply chain's capability to meet the core demand it is designed to meet. Consequently, the function has a high impact by constraining itself by offering a simpler solution where it is desired. This can come at cost of customer satisfaction and loss of sales, but this is justified by the internal cost savings that are obtainable. Lastly, if sales focus on a predictable demand, a lower demand variability will follow and more accurate forecasts can be created which helps upstream activities plan better and minimize excess costs (Fisher, 1997; Yu-Lee, 2002).

Operations

Operations have a high impact on the performance and efficiency of the supply chain (Nakano, 2020). In terms of capacity for manufacturing, the function should strive to have a high utilization rate of resources (Olhager, et al., 2001). By maintaining a high degree of utilization, operations will minimize excess resources and thereby reduce costs. However, if demand increases, capacity should also do so but preferably in a lag manner so that utilization remains high. Furthermore, the actual manufacturing

process should exploit economies of scale by having long production runs with few changeovers. This can impact efficiency as cost per unit will decrease due to fewer fixed costs diluted over more products (Chopra & Meindl, 2013). The lead time of the manufacturing should also be minimized if it does not jeopardize cost minimization (Fisher, 1997). Lastly, inventory management can have a high impact on efficiency. By focusing on minimizing inventory throughout operations without causing production stops, higher asset efficiency and a higher turnover will be achieved (Chopra & Meindl, 2013). A level strategy is appropriate to use if operations face a foreseeable future demand which exceeds capacity. By leveling supply over a longer time, capacity does not have to be changed to meet higher demand and a high utilization profile will be kept (Anupindi, et al., 2012). With that said, inventory is not to be removed completely as it plays an important role in smoothening production and achieving economies of scale. However, if attention is put on eliminating excess inventory, higher efficiency will be achieved. The focus on designing operations to achieve high productivity and decrease cost per unit impacts the function to be less flexible to meet changing market demands due to the rigidness of the operations setup and lack of extra capacity (Chopra & Meindl, 2013). To summarize, with high-capacity utilization, smooth production, and optimal inventory levels, a cost-efficient operation can be achieved.

Sourcing

The sourcing function has its main impact on efficiency by reducing spend on purchased products (Fisher, 1997). By selecting suppliers with a cost-savings mindset, the supply chain will operate at a lower expense as the cost of purchasing will decrease which impacts operational efficiency. There are various ways to achieve this, but they are outside the scope of the thesis. Furthermore, an efficient supply chain should try to reduce lead time without increasing cost. From a sourcing perspective, reducing lead time is then a second criterion for reducing cost (ibid). On the topic of volumes, an efficient supply chain does not want to hold excess inventory and suppliers should then also be selected based on their ability to deliver in a long-term perspective that leads to a low and stable inventory with little holding costs and tied up assets (Nakano, 2020). However, even if minimizing inventory is important, inventory levels should always be sufficient to support operations and prevent shortages. Lastly, one way of attaining a low-cost profile is by leveling supply over time to be able to meet future demand (Olhager, et al., 2001). If this is the case, then suppliers should be selected based on their ability to competitively enable a stable surplus of inflow of material over time to allow for a level strategy.

Product management

With a functional product in mind, the product management function has an impact on efficiency by designing a product that is maximized in performance at a minimum cost (Fisher, 1997). As the functional product is simple in its nature, the product management should leverage this limitation and focus on a design and development which maximizes relevant performance aspects while also minimizing costs. Furthermore, creating more product variety increases the unpredictable demand for the product and makes efficiency in terms of manufacturing and inventory harder (Closs, et al., 2010). By simplifying the product assortment, efficiency can be achieved. This focus does however decrease configurability and the portfolio of products offered.

Figure 5.3 illustrates how an efficient supply chain would fit in the supply chain triangle framework. The Figure shows the main aspects of how integral functions of S&OP can improve cost and asset aspects through tradeoffs that affect the service offered. By neglecting performance aspects that contribute to supply chain responsiveness, prioritization can be placed on maximizing internal efficiency and cutting costs.

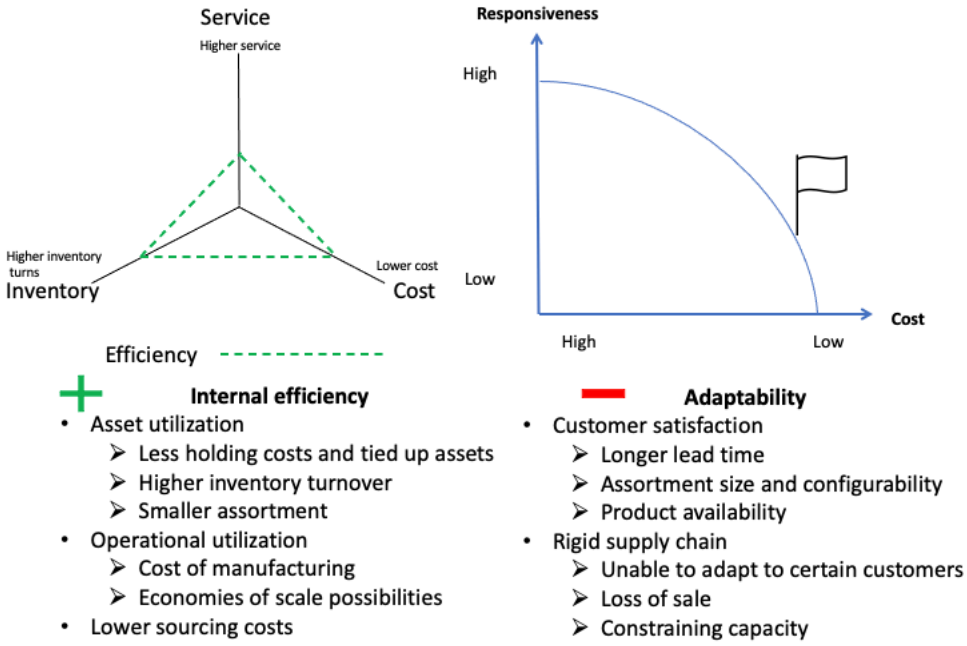

Figure 5.3. An efficient supply chain in the supply chain triangle framework. Created by authors.

Table 5.1 summarizes how the integral functions of S&OP can impact supply chain performance from a responsive and efficient perspective. Furthermore, it concludes what the aim of each function should be and how it will translate to an impact on the supply chain.

Table 5.1. Summary of supply chain performance impact of integral functions of S&OP.

Function		Sales	Operations	Sourcing	Product management
Responsiveness	Aim	• Utilize service level • Adhere to customer demand and pursue sales	• Shorten lead time and cycle time • Shorter production runs and more changeovers • Deploy excess capacity • Keep safety stock	• Prioritize delivery speed, accuracy, and agility • Suppliers should enable inventory to be kept and demand to be chased	• Drive modular design to enable postponement of product differentiation • Keep a high product variety
	Impact	+ More orders filled and increased service level + Increased revenue and market share	+ More capacity & flexibility + Shorter lead time - Increased cost per unit - Lower inventory turnover	+ More material availability + Shorter lead time - Increased cost of purchasing	+ Design scalability + Shorter lead time + Broad assortment - More inventory - Static product architecture

Efficiency	Aim	• Acceptable service level
		• Focus on predictable demand
		• Provide availability
			• Smooth production
			  • Longer production runs
			  • Fewer changeovers
			• Increase capacity utilization
			• Increase asset utilization
				• Reduce spend
				• Suppliers should enable inventory to level demand and be minimized
				• Reduce lead time, but not if it increases costs
					• Maximize performance and minimize cost
					• Simplify assortment

	Impact	+ Simple offer
		+ Predictable forecast
		- Unable to meet uncertain demand
		  - Loss of sale
		  - Customer satisfaction
			+ Increased productivity
			+ Decreased cost per unit
			+ Higher inventory turnover
			- Less flexibility
			- Less extra capacity
				+ Decreased cost of purchasing
				- Risk of material shortage
					+ Less product variation
					- Decreased configurability and product portfolio

5.2 Empirical pattern matching

The following section is dedicated to highlighting and analyzing the patterns that were observed during the empirical data collection and combining this data with the findings in the literature review. The method used to find these issues is pattern matching from the interviewee's experiences, observations, and reflections. The identified gaps that are analyzed in terms of causes are defined as plan adherence and inventory turnover. See the description in Table 4.2.

5.2.1 S&OP Plan adherence

Alfa Laval GPHE has in their implementation of S&OP managed to successfully adhere to many best-practice examples of what needs to be included in the process and how it should be set up according to literature e.g., Tuomikangas & Kaipia (2014). The organization has invested heavily in trying to ensure the success of the process. They have top management ownership dedicated to the process, they are aligning BU strategy with production strategy, measuring, and managing performance through all the right KPI's, and both have and are further implementing advanced IT tools that will assist in the process. They prepare forecasts and scenarios, plan, and discuss according to the set guidelines of the process. All integral functions are to some extent doing their part in making sure that the iterations are maintained every month. Alfa Laval GPHE has much going for them that should place them in a great place to gain fantastic results with the process.

While all the interviewees acknowledge that they have seen significant improvement in the organization compared to before implementing the S&OP process, it is not taking off. Alfa Laval GPHE is not able to completely reap the full potential benefit that a well-implemented process can provide. Many are viewing the process as more of a tool or forum that facilitates a dialog for cross-functional collaboration in the BU. They see the process as an enabler that provide a collective responsibility for the success and failure of the BU. A compass that ensures that every business function is running in the same direction. They state that with S&OP, the previously seen high degree of silo thinking or white spaces between the business functions, and the act of primarily attending to benefits of the own function have been rendered obsolete. Despite this, there are several respondents that have stated that there is an observable discrepancy in how business functions are interpreting and executing the plans that are decided upon in the S&OP process.

A pattern has been observed suggesting that when the extended time horizons that are considered in the S&OP forecasts are translated into shorter and more operational time horizons, something prevents the execution. As the S&OP plans are regarding decisions on a 4–18-month time horizon, they can often include incentives requiring changes in production capacity to correspond to demand forecasts. Changes that can take much time to successfully implement, and that sometimes need to be initiated immediately. The plans are shared with factory planners at the various facilities and are expected to be completely followed. However, multiple interviewees report that this is not always the case. In several instances there are mentions of a lack in the execution phase of the S&OP process, speaking of a disconnect or gap between the strategic plans and how operations decide to act on these plans, see Figure 5.4.

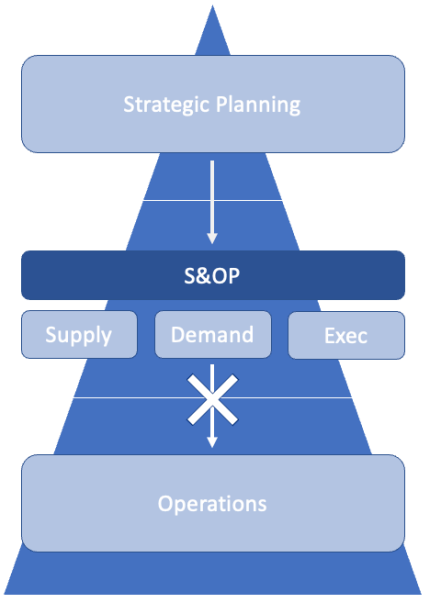

Figure 5.4. Gap often observed between S&OP and Operations. Created by authors.

Several respondents report that the entire iteration of the S&OP process is functioning as intended but when the plans are delivered to be acted upon, they are not regarded as an absolute truth. Instead, employees are more inclined to trust their own intuition and previous experience rather than following a forecasted plan that is created and delivered to them. Findings to three aspects as to why this gap occurs at Alfa Laval GPHE are shown in Figure 5.5 and will be discussed in the following section. These aspects are highly influenced and affected by the general knowledge and awareness of the S&OP throughout the business unit.

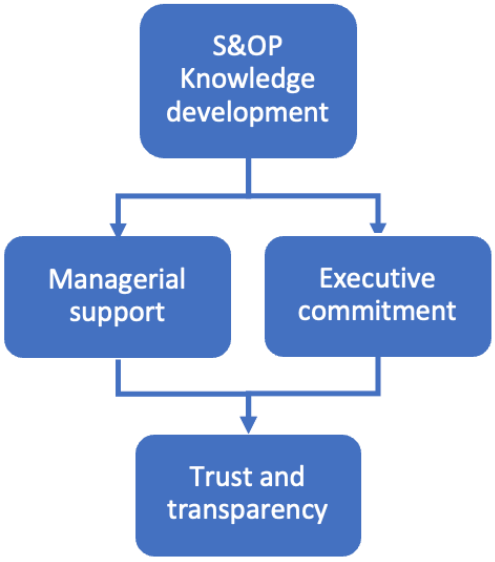

Figure 5.5. Knowledge development and three affected aspects. Created by authors.

S&OP Knowledge development

Alfa Laval is a company that produces a market-leading product, and they remain to be regarded as a company that is pushing the boundaries of innovation in their industry. It is obvious that there is no shortage of knowledgeable and competent employees within the organization. However, when it

comes to the S&OP process there are several mentions of suboptimizations due to a lack of knowledge and awareness about the process. Following this knowledge gap comes a lack of taking initiative to improve the work and process, drawing own conclusions from data, and analyzing the ever-changing scenarios. There is not one singular S&OP phase or integral function that is lacking in this field, rather the issue is seen generally throughout the process and its integral functions. It is believed that all affected parties would see benefits from the optimization that an increased knowledge would imply (Tuomikangas & Kaipia, 2014). One area that exemplifies this lack of knowledge and awareness is that the various business functions does not see how their work is affected by the process in a tangible way. Moreover, they are not aware as to how their work as a business function is affecting the process and other business functions within it.

Executive commitment and managerial support

Corporate culture and leadership are regarded as one key enabler and facilitator of a properly functioning S&OP process, and it is the management's task to ensure that this is well established in an organization (Tuomikangas & Kaipia, 2014). People have a natural tendency to follow the initiatives and behaviors of those they view as role models or that are in superior positions. By having one or several executive managers as ambassadors and enablers for the growth and development of the process that is S&OP, it can be ensured that it becomes more than merely a complex tool (Stentoft, et al., 2020; Boorman, 2013). An ambassador who in this case should know all the ins and outs of the process and that is convinced of the gains it can provide. In the S&OP process at GPHE, they currently have top management ownership for the process that acts as an ambassador for it. However, with the gap situated between delivering the plans from the executive meeting and acting on them in operations, Figure 5.4, the initiatives are not pushed down and shared in the organizational hierarchy. Thus, it is evident that the void between the different levels in the hierarchy is too large for one person to overcome. There is no feed-forward of the initiatives from the ambassador that are encouraging managers to make sure that their teams become more aware of the process and want to increase their knowledge about it. The task of being a role model and ensuring that information and knowledge development are passed on needs to be divided among the respective managers (de Oliveira Pedra Romão, et al., 2022).

This managerial lack of passing on the incentives of knowledge development is highly affected by the knowledge and awareness that the mentioned managers have themselves. If the managers are not made aware of the benefits obtainable through further development of the process, there is a risk of them becoming falsely content with how the S&OP process operates. There have been unmistakable benefits and value added with the implementation of the process at GPHE. With such a large gain, there is a risk that it inhibits the willingness to learn more and to dig deeper into the subject. Instead, there are more urgent matters to attend to. Because: "*why fix something that is not broken?*". For this to happen the additional benefits that can be gained must be convincing enough for such an effort, and this persuasion is obtainable through education and process development (Boorman, 2013), driven by leadership (Grimson & Pyke, 2007).

Another way that the lack of executive commitment and management support is affecting the S&OP process is in the execution phase. When the final plans should be distributed across the integral business functions every month, it needs to be done in a way that signals a certain confidence. If there is not sufficient assurance from the executive meeting that these plans are established so that they provide the highest benefit, then why should the recipient blindly trust them? Therefore, first the manager must be convinced that the plans which are agreed on in fact are the best way forward. That there is no other better way of going about the future and that there are no scenarios that are overlooked. But if the manager lacks the knowledge that ensures their confidence that no other

scenario could provide more value to the BU, they might not prevent their team from not fully executing in accordance with the plans (Stentoft, et al., 2020).

Trust and Transparency

Without an appropriate level of trust between functions in an organization, there is a risk that the implementation of certain plans falls short (Van Hove, 2017). The S&OP process is placed in a strategically important planning horizon where the produced decisions and plans have a significant impact on the receiving partner. These can be large investments in machinery, large purchases of material, or in contrast termination of employee contracts. Many of the decisions have a large impact on the financial result of the concerned business function and that creates a threshold to trusting them blindly. However, the goal of the S&OP is to take informed and calculated decisions based on scenario analysis, and when these decisions are taken it is the responsibility of all the stakeholders to manage the resulting risk and outcome. Every scenario possible should have been brought to light and discussed and it is not up to the receiving party of the plans to refer from executing them. But if factory planners in operations that receive these plans are not made aware of what goes into them and the considerations they include, they can be reluctant to trust them completely (Tavares, et al., 2012). Even more so if there have been plans created containing scenarios that have not been realized which could potentially damage the level of trust provided when acting on the plans.

5.2.2 Inventory turnover

The inventory turnover issue and the cause of it was analyzed from a strategical alignment point of view to understand the BU strategy and the strategy of the integral functions of S&OP to understand if the cause of the gap could be attributed to a strategical misalignment. Figure 5.6 below shows the structure of the relationship between the strategy of the BU, functional strategies, and supply chain strategy.

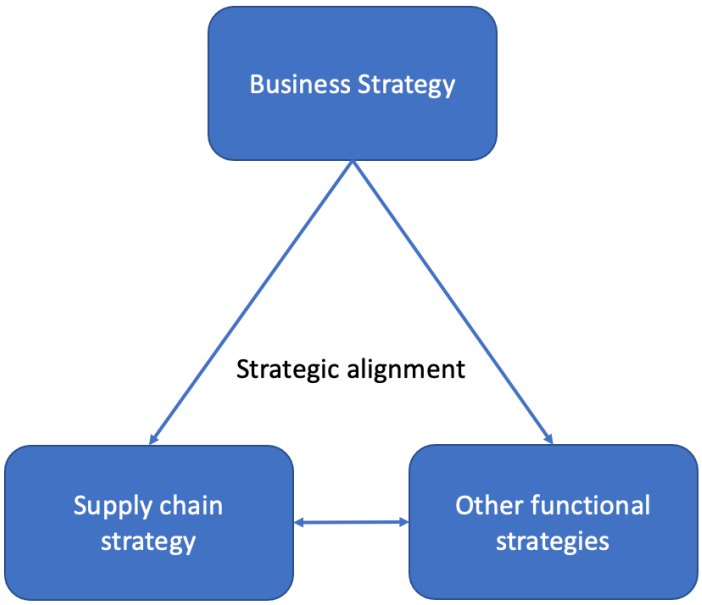

Figure 5.6. Alignment between business unit and integral functions of S&OP. Created by authors.

Business and supply chain strategy

The strategy set by the BU mainly prioritizes two objectives. Firstly, it indicates that the goal is to deliver a product that is exceptional in performance and available to customers' demand. Secondly, the BU also strives to deliver services to customers throughout the product life cycle and a tailored solution for each customer. This strategy can be regarded as a hybrid between product leadership and

customer intimacy (DeSmet, 2021). In this context, the BU also prioritizes that this is done with efficient use of assets.

The product leadership strategy can be analyzed by studying the product aspects of demand, see Table 3.6. Theory from Fisher (1997) suggests that a responsive supply chain should be appropriate for gasketed plate heat exchangers. This is mainly due to three aspects of demand which correlate with an innovative product. The product life cycle varies between products, but it is generally always longer than one year. The contribution margin is high and generally over 20%. Lastly, there is a high amount of product variety. Even if relevant, the other aspects of demand are hard to compare as they do not translate well to this industry. The strategy of providing an excellent service to customers implies that the product variety and assortment of products need to be big so that each product can be tailored to a customer's need. Consequently, many components and parts need to be kept in inventory to enable this customization. As the efficient supply chain aims to minimize inventory and works best with a product that has few variants, this is considered as a bad fit (ibid). A responsive supply chain better aligns with the strategy of providing a tailored solution. The strategy looks to keep excess manufacturing capacity and inventory so that a customer with an unusual demand can be dealt with (Chopra & Meindl, 2013). Furthermore, the responsiveness of the supply chain allows for a fast response to uncertain demand and still delivers it at a competitive lead time. For instance, if sourcing and manufacturing of a special solution are needed, then the lead time of a responsive supply chain will be beneficial. Lastly, the strategic goal of increasing asset efficiency is not entirely aligned with the goals of a responsive supply chain. Mainly because a responsive supply chain looks to keep excess inventory as a buffer to demand (Fisher, 1997). This is counteractive to the goal of increasing asset efficiency. However, this is by the company considered a "secondary" goal. Meaning that inventory should be reduced, if possible.

Furthermore, as the BU is keen to grow its market share and revenue, the responsive supply chain supports performance aspects that aim to generate a better service level through speed and availability (Nakano, 2020). This is not only theoretically accepted as a competitive attribute (Ballou, 2006), but it also allows the BU to capture certain aspects of demand, parts of the market, which could not be reached otherwise. By investing in a capacity that enables more demand to be captured, new revenues streams and market shares can be gained (Yu-Lee, 2002). Through the product group, the BU shows many initiatives that support the fact that a responsive supply chain is the goal. For instance, investing in operations cycle time improvement, keeping excess inventory and capacity, and sourcing suppliers that provide short lead times. With a responsive strategy, theory suggests that excess buffers of inventory should be kept (Fisher, 1997). As a result, larger holding costs and lower inventory turnover should not be alarming. However, it is the perception of the BU that, compared to historical performance, too much inventory is being held and this could be done more efficiently without disturbing responsive performance attributes and losing sales.

Alignment of integral functions of S&OP

Having understood the business strategy and how it translates to supply chain strategy, it is necessary to analyze the integral functions of the S&OP. By evaluating their objectives, actions, allocations of resources, and issues, the strategic alignment and cause of the gap can be evaluated.

Sales

The sales function is focused on market share and tries to win as many sales as possible. In this mission, ES and PS also work closely with product management to develop new products and get them onto the market. From the central sales management to the local sales offices, there is somewhat of a disconnect as the local offices support more than one BU and operate more independently. As the local offices are incentivized by gross margin and selling the most profitable products, they are not as

concerned with what products they are selling. As a result, ES and PS both sell old and new products that have the same applications. This creates issues as it forces other functions to be adaptive to a large variety of products. The implication of this product variation becomes even greater with consideration of the complexity that goes into the components necessary to make each product. Furthermore, it creates issues for the conversion and phasing out of old products as they are continuously being sold and must be kept in the assortment. This affects operations, sourcing, and product management as they are responsible to produce, source and manage these products. To summarize, the goal of growing market share for ES and PS is locally done with little regard to what products the BU strives to keep and phase out.

Sourcing

Regarding the limitations of sourcing in this thesis, the objectives pursued by the function generally indicate a structure that supports a responsive supply chain. As suppliers are evaluated and selected based on their capability to deliver on time and variability in lead time, a source of material input is created which focuses on securing material availability which enables service levels and ultimately responsiveness (Fisher, 1997). Furthermore, suppliers are also selected and sourced for situations where a short lead time and agility are essential, thereby also promoting responsiveness. The sourcing evaluation of cost is in theory supportive of an efficient supply chain (ibid). However, according to the sourcing at GPHE, suppliers are selected in terms of cost as a final decision category if they can meet lead time and delivery variability requirements. To summarize, sourcing selects a supplier based on factors that should create a responsive supplier network.

Operations

In operations, most examples suggest that actions are taken to promote a responsive supply chain. Manufacturing capacity is monitored ahead of future demand with the goal of preparing operations to always have a surplus of capacity compared to demand. If investments are needed to raise capacity, they are provided. The structure of GCC and LA also suggests a postponement structure where LA is "decoupled" from GCC so orders can quickly be assembled on demand. This all exemplifies a responsive manufacturing process (Fisher, 1997). Supply of material is also kept in excess so that operations can chase demand in case it increases. Also, inventory is held with the goal to ensure service levels and availability of products at a high standard. Furthermore, examples of investment in operations show that performance factors such as cycle time are actively being addressed to improve lead time and output. Altogether it exemplifies a function that aims to support a responsive supply chain (Nakano, 2020).

Despite showing attributes that support a responsive supply chain, operations hold an excessive amount of inventory which creates a low turnover. This is because the M-series and older product lines are still being sold and product management has been unsuccessful in phasing out these product lines, operations are forced to keep an inventory for a large assortment that has varying demand. Theory from Closs, et al., (2010) suggest that more inventories must be kept to meet orders for a more complex product portfolio. Similarly, GPHE has a large product assortment which forces them to keep more inventory to be able to meet all orders. Furthermore, large parts of the inventory is obsolete and only needed for specific situations which makes planning for inventory turnover harder. The demand that used to be spread out over the M-series and older product lines and was supposed to be spread out over the T-series is currently diluted over all product series. Because of the strategy to have an available product and tailor it to customers' needs, operations find themselves in a situation where they must keep inventory available for a large assortment to meet orders.

Product management

The focus of product management is to develop new products in line with the demands of the market so that GPHE's products remain competitive in terms of innovativeness and performance. This focus on developing an innovative product is aligned with a responsive strategy (Fisher, 1997). In this mission, they work closely with R&D and sales when developing the product, while also coordinating with operations to ensure the feasibility of the production of new products. This development has included a standardization design of certain components that have enabled end customization for customers to be done in a responsive way (Huang & Li, 2008). The function has successfully launched a significant number of T-series products in a short amount of time. However, the simultaneous project of phasing out the M-series and even older product lines has not been successful. This is mainly attributed to the fact that the old product lines still have competitive relevance on the market and is still offered and sold. Ultimately, this has led to a situation where product management has an active assortment of old and new product lines which serves the same application and purpose. This product portfolio becomes large due to the many configurations and variants that the products can be produced after. Furthermore, this creates an issue with controlling and reviewing the assortment. Phasing out a product becomes even harder as part of the assortment is obsolete, but never becomes terminated as scraping a product means that it cannot be delivered which restricts sales. The issue further becomes troublesome, as the old products are still being sold.

Conclusion for cause of inventory turnover

Starting from the business strategy, the allocation of resources and actions of functions integral to S&OP shows that attributes of a responsive supply chain are promoted. Based on the analysis of empirical data and literature above, this is concluded to be the right decision regarding product aspects of demand and strategic objectives. Despite this, the inventory issue suggests that there is something in the alignment between functions that is the cause of the problem. Sourcing and operations structurally make decisions that promote the responsive performance of a supply chain. Sales furthermore try to leverage this responsiveness to meet uncertain demand and increase market share and revenue through a high service level. Product management also focuses on developing a product that has features and demand aspects which make it innovative. This general alignment seems to suggest that most actions of the integral functions of the S&OP make decisions that are in line with a responsive strategy and that an internal strategic misalignment is not the cause of the problem.

However, there is a pattern of what Simatupang and Sridharan (2005) defines as a discontent. This discontent can be seen between functions and how their individual actions cause an imbalance which ultimately is seen in the inventory turnover performance. The cause of the inventory problem can best be described by starting with the actions of local sales. As they operate independently from the BU and are incentivized by selling products with the highest margin, they unaffectedly continue to sell the old product lines which were supposed to be replaced and phased out years ago by the T-series. This issue further resonates to product management as their product assortment then contains "parallel" product lines. Restrained by the goal of servicing customers with a tailored solution, the function has been passive in phasing out old product series that still has a demand. Lastly, these actions affect operations as the functions keep inventory to secure availability and a high service level. Because of the large assortment, the function not only has to keep a lot of inventory but as the product lines serve the same purpose, demand is diluted over more products. Based on Simatupang and Sridharan (2005) theories of discontent, this sales behavior is considered to have characteristics of "rivalry" where local sales have a high concern for their own interest and little for product management and operations. On the other hand, product management and operations show a "forbearance" behavior where they accept the sales interest and neglect their own and adapt. The sources of discontent can best be described as Simatupang's and Sridharan's (2005) definition of "misalignment". The local sales reward

on commission after profit of sales and does not optimize the whole and causes disturbances for product management and operations especially. This leads to a situation where lots of excess and obsolete inventory is created. The low demand for many of these products causes inventory turnover to be low and somewhat unaffected by rises in demand. Table 5.2 below shows the actions and results that summarize this analysis.

Table 5.2. Conclusion of cause of low inventory turnover.

Function	Sales	Operations	Sourcing	Product management
Action	• Pursuing market share and growth • Local sales incentivized by margin • Indifference to sale of new or old product lines	• Keep excess inventory to secure service level and availability • Capacity leading demand • Postponement • Lead time reduction investment	• Select supplier after delivery on time, lead time variability, and cost • Select supplier for agility	• Develop innovative products • Component standardization • Successful launch of T-series • Unsuccessful phase out of old product lines
Result	• Large assortment • Unable to phase out old product lines • Low inventory turnover ➢ Excess inventory ➢ Obsolete inventory			

Figure 5.7 illustrates the current situation where a large inventory with low turnover is experienced due to the stress from providing a high service for products and configurations from a very large assortment. Furthermore, it shows the high costs that follow for functions to be able to perform in a responsive manner that upholds this service.

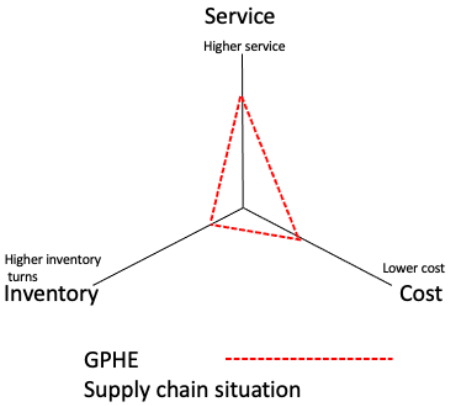

Figure 5.7. Illustration of the current supply chain situation at GPHE. Created by authors.

5.3 Addressing identified gaps

To bridge the gap that is seen between the S&OP plan and execution, a couple of recommendations are made. These aim to suggest how certain improvements could help GPHE to improve their plan adherence and inventory turnover so that plan and execution of S&OP are better aligned with the strategic targets of the BU.

5.3.1 Plan adherence

Findings in the data suggest that there is one primary issue that should be attended to so that the S&OP process can operate more efficiently. The previously mentioned gap that is hindering operations from adhering to the plans outputted from the executive S&OP meetings is an effect of knowledge development and general process awareness. The findings in this thesis showcase that without an appropriate level of knowledge there will potentially be an inability to both produce plans that are possible to completely execute on and to adhere to these plans. This is not an effect of employees and resistive to S&OP, quite the contrary, instead, it is an effect of not being aware of what has gone into

decisions and how they can potentially improve current processes. So, to resolve this gap and increase the efficiency of the S&OP process in general it is important to address the actions at the root cause, and thus increase the overall knowledge and awareness of S&OP at all integral business functions.

Managerial knowledge

It is a prerequisite that the managers and executives that are directly involved in S&OP are knowledgeable role-models and ambassadors for the process for it to be successful (Tuomikangas & Kaipia, 2014; Boorman, 2013). Currently, in Alfa Laval GPHE, this is not entirely the case. But by developing the knowledge of the managers and executives that are directly affected by the S&OP process there are some obvious gains that can be obtained. They need to be convinced that with the process running at an optimal level, they will see vast benefits, even from their currently relatively well-operating process. More importantly, they should be educated so that they become motivated in achieving this themselves, they cannot be forced to want change and improvement. Without this convincement and motivation, it's not possible to demand further investments, neither monetary nor in terms of time and effort from employees to fully embrace the development. But by exemplifying different scenarios on how the process is implemented differently in various other organizations they can see how it could be customized to better suit the needs of Alfa Laval. This in turn could be the motivating factor that creates an incentive of improvement, which ultimately will allow for further investments. The management and leaders of the business unit should invest in training material, lectures from experts and workshops, etc., to convince their colleagues to become ambassadors of the process and becoming motivated for its development. Increasing the managerial knowledge on S&OP initiatives could be easier distributed across the organization. It would enable a way of sharing the responsibility for the success and development of the process which is currently lacking.

By having the managers of each of the business functions being experts and role-models that ensure the knowledge development in their own business functions, Alfa Laval GPHE would see several benefits and increased process efficiency (Boorman, 2013). Primarily it would be in the way that the process is adopted and tailored for GPHE. By not being content with the development they have seen so far will enable them to advance the process further. Additionally, it would create what Tuomikangas and Kaipia (2014) refer to as a S&OP culture in the BU which is favorable for the success of the process. The organizational culture, such as commitment, collaboration, and trust, as well as practices such as formal planning, staff training, and communication, are all factors that are directly affected by how the leadership are supporting the process. Finally, the increased development of managerial knowledge of the process would increase the resource allocation in it. Managers would through this be able to make better decisions regarding e.g., workforce and equipment with this increased knowledge.

Concludingly, developing the managerial knowledge would enable the S&OP process to continuously see development and that the plan adherence is kept at a high level. When employees in the respective business functions are made aware that their managers appreciate the importance of adhering to the plans so will their colleagues. The motivation and dedication of employees to provide feedback and development of the process originate from managers and supervisors being experts that facilitates and encourages such a mindset and organizational culture. However, they need to be educated and provided with the vision that motivates them respectively. Furthermore, this will enable them to continue the task of developing the process as they are made aware of other potential benefits that can be seen.

General knowledge and awareness

By increasing the general knowledge and awareness of the process Alfa Laval will be able to see several areas of increased efficiency in their current S&OP process. This knowledge can be distributed to both the integral functions of the process that are working with it regularly and the directly affected functions of the process, as well as those functions that are indirectly affected by it. This should be done through an initiative that includes training material in the form of digital courses, lectures, workshops, etc., to increase the general knowledge and awareness of S&OP and the consequences of not adhering to the plans. But more importantly, it should include an element that incentivizes employees to complete the training material. A curriculum with information and learnings should be available for all employees within the integral parts of the process, additionally it should also include material that is mandatory for all directly involved parties or integral functions. Such mandatory elements could be concerning scenario planning, performance measures, IT systems, and forecasting to mention a few, but of course this should be decided and customized with the development of the process. Followingly, there should be information delivered through internal channels on success stories or other important news to spread awareness of S&OP. Employees across the BU and organization should know that the process is employed and how the work of different business functions affects the process.

One key benefit they will see from this initiative is an enhanced collaboration within their business unit and the integral functions of the process. This increased collaboration will in turn provide a better shared understanding that enables employees to know how their work affects the process and how the S&OP process affects their work. Additionally, it will enable an increased knowledge for the operations department of the organization's strategy, goals, and challenges and how these are translated into the S&OP plans that they are expected to execute. By knowing that all employees share a baseline knowledge of the process they will also see increased collaboration since they will have a common language and framework from where they can effectively communicate. They will be empowered and encouraged to improve on the process (Tuomikangas & Kaipia, 2014). From there have an easier way of identifying potential issues and potential improvement opportunities with the process and delivering these findings back to the concerned phase, which otherwise would go unnoticed. Furthermore, this enhanced collaboration will prove to be beneficial to the lacking level of trust and transparency experienced in the business unit. This will be an effect of the increased awareness of what has gone into the S&OP plan as well as why they are expected to follow the plan instead of relying on their experience and expertise. Sometimes in S&OP, it is more important to follow and execute on the executive plan, so to fulfill the long-term strategic goals, even though it might cause short-term disadvantages.

Concludingly, by increasing the general knowledge and awareness of the process in the BU, the disconnect between the S&OP iterations and operations executing on their plans would greatly decrease. The enhanced collaboration would increase plan adherence, promote teamwork, and create a more efficient and effective S&OP process which in turn will increase strategic alignment.

5.3.2 Inventory turnover

Two recommendations are made that address the root cause of the inventory turnover gap and improve performance in line with the strategic objectives of GPHE.

Incentivize conversion

As it currently stands, integral functions of the S&OP exemplify supply chain discontent which originates from misalignment, where individual functions are rewarded for actions that do not benefit the whole. Product management wants to phase out old product lines, like the M-series, but are

unable to do so as local sales continue to be incentivized to sell them. Consequently, operations and sourcing must adapt to the circumstances and build up a large inventory with excess and obsolete stocks as a result.

A simple solution would be to scrap the old product lines so that they cannot be sold and thereby decreasing assortment and enabling a phase-out of obsolete products. However, this binary solution could pose some unnecessary risks. By just removing the M-series, for instance, current sales processes might be affected and thereby jeopardizing the service of the company. Furthermore, GPHE expressed that part of the reason for selling the M-series is that the salespeople know its technicalities better than the T-series. This makes a quick change troublesome.

Simatupang and Sridharan (2005) claim that an antidote for a misalignment discontent is to choose a coordination structure that energizes incentives among the supply chain members. It would then be fitting to design incentives so that all members are incentivized to make individual decisions that attribute to total performance. A holistic recommendation that creates a common incentive based on the theories of Rummler and Brache (1991) that promote cross-functional collaboration is then suggested. As local sales gain commission based on margins of sales, it is suggested that the internal commission model is changed so that commission is still based on margin but with adherence to what product line it is. If a salesperson would sell a high margin product that also is a T-series, then they would get extra commission. On the other hand, if a salesperson would sell an old product line with a high margin, then the commission would not be as much. The outcome of a decrease in sales of old product lines is of course desired by the product management as they are then more able to phase it out of the assortment. However, for this to work, cross-functional collaboration is necessary. It has been expressed that there is resistance to selling the T-series due to the lack of technical knowledge of the new product and the comfortability of the old ones. For product management to get the desired behavior of converting sales of solely to T-series efficiently, it is then in their interest to increase the knowledge of the salespeople. As product management is central to developing product features and functions, they can be a good source of knowledge that can support local sales in this transition. In addition to changing the commission model, it is also recommended that local sales and product management are incentivized through gain sharing. If both product management and sales would gain financial benefits based on the “conversion rate” then that would not only further incentivize local sales to sell the T-series, but also the product management team in enabling sales to perform in the best way possible. With this incentive, product management would be keen to provide material and support to raise local sales knowledge of the T-series, which has been an expressed concern. By doing so, knowledge of the T-series will be raised which is important for local sales when selling to customers. With local sales being more incentivized to sell the T-series and trained to do so, product management is better able to phase out the old product lines. This will further affect operations as the assortment they have to keep in stock becomes smaller. Obsolete items can be scrapped, and demand is concentrated over fewer products which should enable inventory turnover to be better handled. Lastly, as the T-series is designed to replace the M-series and even older product lines and has better functionalities than them, no configurations are discarded, and the same tailored products can be provided to the customer. With this logic, service level should not be affected. To summarize, by changing the sales commission model to promote sales of the T-series and creating a shared financial incentive to achieve a higher conversion rate, the old product lines can constructively be phased out and the assortment decreased.

Drive modularization

Historically, GPHE has leveraged the benefits of postponement through standardization which has enabled them to decrease product variety and lead time while still offering customized products.

Currently, GCC manufactures components to stock based on forecasts of LA's demand. This has enabled them to push the decoupling point closer to the customer which can help lead time and responsiveness. Because of standardization, LA can assemble components on order from a stock that can be mixed in an efficient way which helps decrease product complexity and variety. However, the idea of modularization was not utilized in the old product lines and has been developed to a little degree in the T-series. It is then our recommendation that focusing on implementing modularization in the T-series could yield benefits that not only address the inventory turnover gap but also aligns with the strategy of the BU.

Modular development can enable GPHE to further build on its idea of using standardized components across products to keep complexity down. By designing modules that work across products, the BU can increase internal standardization on a modular level without constraining final configuration (Huang & Li, 2008). With the current setup of GCC and LA, a decoupling point has been established between the two where LA assembles to order from stock received by GCC. If standardization of components could be further developed to modules that work across products, then the variation of stock keeping, and assembly, would be improved. If done right, this can enable GPHE to offer the same product design variance and configurability with a smaller variation of parts. Firstly, this is highly useful as the current inventory situation lacks a consistent aggregate turnover due to excess and obsolete inventory. With modularization, GPHE will be able to decrease the assortment size and thereby concentrate demand over fewer parts. This will increase turnover as it eliminates the need for individual components and parts that currently are the cause of an excess assortment and obsolescence. Furthermore, opting for more modularization is also in line with the strategy of the business unit. As modularization does not change the functionality and variance of the products, GPHE can continue to be competitive by offering a tailored product with exceptional performance. Lastly, modularization is also aligned with the responsive supply chain strategy. As the concept looks to decouple sub-processes of manufacturing, postponement can further be utilized which will delay the differential decision. This enables flexibility and a faster lead time offering towards customers.

To summarize, by creating a common incentive that financially promotes the selling of the T-series while also increasing the technical knowledge of the product line, the size of the assortment will shrink, obsolete products can be phased out, and inventory turnover increased. Furthermore, through driving modularization development concepts of the T-series, product configuration can be achieved with a smaller variety of components which further helps inventory turnover. This also enables further postponement and lead time decrease which is in line with the business and supply chain strategy. Figure 5.8 illustrates how these two recommendations can improve inventory turnover while not harming service and cost aspects.

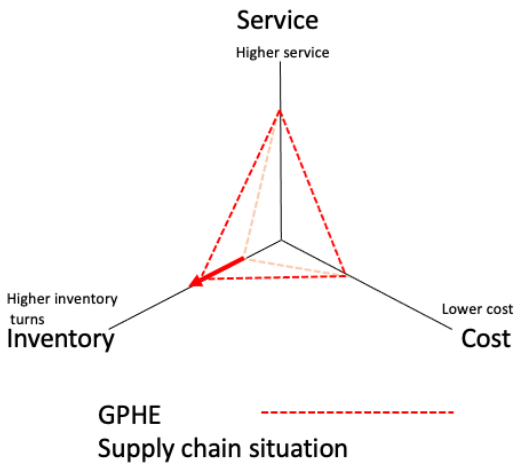

Figure 5.8. Effect of inventory turnover recommendations. Created by authors.

6 Conclusion

This last chapter aims to conclude the main findings of each research question and our final recommendations. Furthermore, it discusses the academic contribution and limitations of the thesis. Finally, it also addresses future research that could contribute to and complement the discussed topics of the thesis.

The purpose of this thesis has been to increase total coordination, performance, and strategic alignment of the S&OP process and its integral functions at Alfa Laval GPHE. This was studied through a case study at Alfa Laval GPHE, where data was gathered from interviews with key stakeholders in the S&OP process and the business unit at large. An analysis of the data was performed using pattern matching and examined against a literature review on relevant fields of theories. The findings of the three research questions that looked to help address the purpose of this thesis are concluded below.

6.1 Research Question 1

How can integral business functions of S&OP impact supply chain performance?

It is concluded that supply chain performance can be categorized after two goals. A supply chain can aim to be responsive where its purpose is to be agile and flexible so that the supply chain can be optimized to serve an unpredictable demand. This supply chain performance is best aligned with a product that has demand aspects that are considered innovative and driving unpredictable demand. The other option is to enhance performance of an efficient supply chain. The purpose of this supply chain is to supply a predictable demand at the lowest possible cost. It is best aligned with a functional product that has demand aspects which are considered to result in a predictable demand.

For this thesis the integral functions of S&OP were identified to be sales, operation, sourcing, and product management as all these functions play a central part in the S&OP when it comes to forecasting demand, deciding on capacity and supply plans, and reviewing assortment and products offered in the plan.

To promote a responsive supply chain performance, operations should have an excess of both capacity and inventory to be able to ramp up production if needed. Furthermore, operations should focus on decreasing cycle times and overall lead times while also prioritizing changeovers in production over long production runs. In line with this, sourcing should select suppliers who provide speed, accuracy, and agility and enable inventory to be kept in excess. Sales impact on a responsive supply chain performance comes through utilizing the responsive performance in the right way. This means that sales should leverage the superior service level and adhere to customer demand to ultimately capture market shares that others cannot. Lastly, product management manages the products to keep their innovativeness. This is partly done through having a large product variety. Product design should focus on modularization so differentiation can be postponed to provide responsiveness.

For an efficient supply chain performance, operations should focus on minimizing excess capacity and inventory so that utilization is high and the cost profile low. Through long production runs, economies of scale can be utilized. Sourcing should select a supplier network that minimizes spend and enables inventory minimization. Speed is a secondary priority. Sales should focus on identifying the predictable demand, setting an acceptable service level, and providing the availability to capture that demand. By championing that profile, sales enable internal functions to focus on lowering costs. Product management should focus on simplifying the assortment so that the variations are kept down. Furthermore, product design should be focused on maximizing performance and minimizing costs. The aim and impact that each function has on a responsive and an efficient supply chain performance is summarized in Table 6.1.

Table 6.1. Impact of integral functions of S&OP on supply chain performance.

Function		Sales	Operations	Sourcing	Product management
Responsiveness	Aim	• Utilize service level • Adhere to customer demand and pursue sales	• Shorten lead time and cycle time • Shorter production runs and more changeovers • Deploy excess capacity • Keep safety stock	• Prioritize delivery speed, accuracy, and agility • Suppliers should enable inventory to be kept and demand to be chased	• Drive modular design to enable postponement of product differentiation • Keep a high product variety
	Impact	+ More orders filled and increased service level + Increased revenue and market share	+ More capacity & flexibility + Shorter lead time - Increased cost per unit - Lower inventory turnover	+ More material availability + Shorter lead time - Increased cost of purchasing	+ Design scalability + Shorter lead time + Broad assortment - More inventory - Static product architecture

Efficiency	Aim	• Acceptable service level
		• Focus on predictable demand
		• Provide availability
			• Smooth production
			  • Longer production runs
			  • Fewer changeovers
			• Increase capacity utilization
			• Increase asset utilization
				• Reduce spend
				• Suppliers should enable inventory to level demand and be minimized
				• Reduce lead time, but not if it increases costs
					• Maximize performance and minimize cost
					• Simplify assortment

	Impact	+ Simple offer
		+ Predictable forecast
		- Unable to meet uncertain demand
		  - Loss of sale
		  - Customer satisfaction
			+ Increased productivity
			+ Decreased cost per unit
			+ Higher inventory turnover
			- Less flexibility
			- Less extra capacity
				+ Decreased cost of purchasing
				- Risk of material shortage
					+ Less product variation
					- Decreased configurability and product portfolio

6.2 Research Question 2

What can be the cause of gaps between GPHE's S&OP plan and outcome?

6.2.1 Plan adherence

While Alfa Laval GPHE has invested heavily in trying to ensure that much of their S&OP process is operating according to what available literature suggests being best-case scenarios, there remains to be room for improvement. Upon closely examining the way they are currently managing the process there are no obvious pain points discovered. Still, several stakeholders speak of a disconnect when the decided-on plans are be executed by operations. This disconnect or gap between plan and outcome can result in inventory imbalances, increased cost, delayed deliveries, and ultimately decreased customer satisfaction.

The concluded most significant factor at Alfa Laval GPHE causing the currently seen poor plan adherence is a general lack of knowledge and awareness of the S&OP process. Upon closer investigation of this factor, it can be further granularized and attributed to three primary factors that are both affected by and affecting the knowledge of S&OP, inadequate managerial support, insufficient executive commitment, and lack of trust and transparency. While it would be easy to put guilt on the receiving party of the plans for not following them entirely, operations are not to hold full accountability. There are much knowledge, experience, and expertise within the organization and if there is not incentive enough to trust the plans that are distributed, the planners could feel like trusting their instinct instead of the plans. If knowledge and awareness on what is considered when creating the plans, or the potential consequences of not following them is not distributed in the BU, there is a risk that they are not considered to be exclusively the best alternative by everybody. Additionally, the knowledge gap is also seen if the executives are not aware of what implications the plans have on the respective facilities and offices. There is a potential risk that the forecasts and KPIs that are presented do not tell a story of the entire truth, instead they become nothing more than

numbers on a screen. And if the managers are creating plans that are disconnected from the actual production capabilities of operations, they will not actually be the best possible alternative. Instead, they will merely be an ambition they can hope to strive towards but not actually meet.

6.2.2 Inventory turnover

The gap described as inventory turnover is an issue experienced at GPHE where they have excess and obsolete inventory that leads to a lower inventory turnover then what they wish for. The cause of the problem was not considered to be any major strategic misalignment. Resources are generally allocated to support a responsive supply chain which was also analyzed to be the best fit regarding the products, the business strategy, and other functional strategies at GPHE.

The cause of the problem lies in the inter-functional dependency. The new T-series that was supposed to replace the old M-series has been successfully launched to the market. However, the M-series and even older product lines has not been phased out. Local sales operate independently and are incentivized by the sales margin. Because the sales employees are still rewarded for selling old product lines and due to their lack of technical knowledge for the T-series, they continue to sell them. This creates an issue for product management as they are unable to phase out the old products which still are demanded. As a result, the assortment is very large. Followingly, sourcing and especially operations must build up an inventory to guarantee a service level for this large assortment. As the assortment contains several product lines that serve the same purpose, the market demand gets diluted over more products. As a result, an inventory situation is created with many excess and obsolete items. The cause of the gap is summarized in Table 6.2.

Table 6.2. Summary of cause of inventory turnover gap

Function	Sales	Operations	Sourcing	Product management
Action	• Pursuing market share and growth • Local sales incentivized by margin • Indifference to sale of new or old product lines	• Keep excess inventory to secure service level and availability • Capacity leading demand • Postponement • Lead time reduction investment	• Select supplier after delivery on time, lead time variability, and cost • Select supplier for agility	• Develop innovative products • Component standardization • Successful launch of T-series • Unsuccessful phase out of old product lines
Result	• Large assortment • Unable to phase out old product lines • Low inventory turnover ➢ Excess inventory ➢ Obsolete inventory			

6.3 Research Question 3

What can the integral business functions of GPHE's S&OP do to be better aligned with strategic targets?

6.3.1 Plan adherence

To make sure that the organization is adhering better to the plans that are created in the executive meetings, and this way better align the S&OP process' outcome with the strategic targets, Alfa Laval GPHE must invest in increasing its knowledge of S&OP. By developing the knowledge and awareness across the organization, they will be able to see improvements throughout all phases of the process iterations. More importantly, it would increase their plan adherence and decrease the disconnect seen between functions. The general awareness of how different business functions is affected by the plans that are considered in the process, as well as how their work is affecting the process, should be

increased. If the employees in the BU know what scenarios have been considered, they will have a higher tendency to execute according to the plans they are handed. Alfa Laval should through an extensive initiative work towards increasing the general awareness and knowledge both for directly involved and indirectly affected business functions. This could be done in numerous different ways, for example, information in internal channels, workshops, or expert lectures to mention a few. This training should be incentivized so to make sure that certain functions are recognizing their current lacks and make use of the knowledge increase. Additionally, Alfa Laval GPHE should also assign one or several employees as ambassadors. They should be convinced in the added value that is obtainable with an ideal process, and motivated to both work towards developing it, as well as work to increase the knowledge and expertise of their peers.

Furthermore, it will prove to be a good enabler that create a company culture where improvement ideas are brought forward and used to develop the process further. This way making sure that the process is continuously under development. Only if the various business functions are made aware of the possibilities and potentials that are obtainable with the process can they wish for the change. This way removing the risk feeling content with the process and instead striving towards always implementing continuous improvements and increased efficiency.

6.3.2 Inventory turnover

Two recommendations are made to GPHE to address the experienced gap between the current inventory turnover performance and the lower one they wish to have. The first recommendation is to create a common incentive between sales and product management that enables an efficient phase-out without harming current businesses. The recommendation includes a redesign of the local sales commission model to promote the T-series and sharing a financial benefit with product management on conversion rate. By increasing the commission for T-series products and reducing it for old product lines, a general incentive will be created that enables a phase-out for the old products, which is desired by product management. However, as a lack of knowledge for the new T-series has been expressed, product management, who have the best knowledge of the products, should provide, and support local sales with material and knowledge so that an expertise of the T-series is created which will further help sales and ultimately product management. Providing support to sales from product management is then incentivized by a shared financial benefit on conversion rate. The consequences of this change will in turn help operations as a smaller assortment will require less inventory to be kept. This will help address turnover as demand will be concentrated over fewer products and less excess and obsolete inventory must be stored.

The second recommendation is to push for modularization in the product design. The operational setup has enabled GCC to manufacture to stock from which LA has assembled on order. As some components are standardized, it has allowed operations to postpone the differential decision and configure products with a mix of components from stock. The old product lines have no modularization, and the T-series has very little. It is then recommended that GPHE further invest in developing a modular design for the T-series. By doing so, the product series can access configuration synergies on a modular level. This will enable product customization from a smaller variety of components which helps GPHE keep a smaller assortment, increase turnover for this smaller component variety, and phase out obsolete inventory. This solution is also in line with the BU and supply chain strategy as it enables postponement and a responsive performance towards customers while not harming the functionality and service offered. The benefits of the two recommendations are illustrated in Figure 6.1.

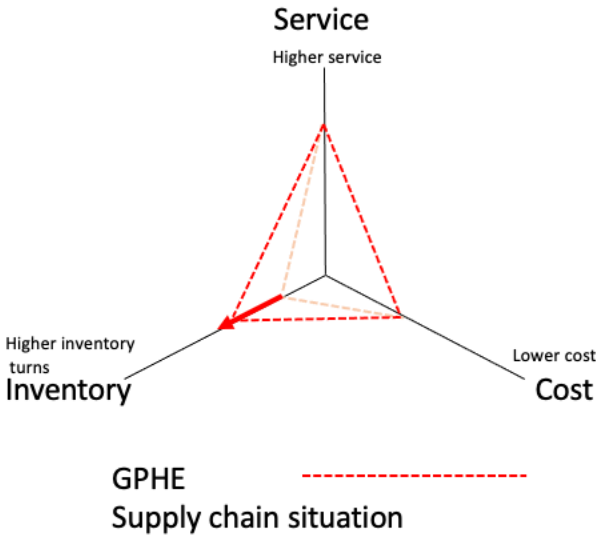

Figure 6.1. Increased performance from inventory turnover recommendations. Created by authors.

6.4 Recommendations

This following section aims to present a concise list of high-level actions to fulfill the purpose of this thesis and address the existing gaps within Alfa Laval GPHE. These actions provide guidance not only to Alfa Laval but also to the readers of this thesis as it will summarize how the existing gaps are recommended to be addressed.

6.4.1 Inventory turnover

Having studied GPHE's specific business and requirements, two distinct recommendations have been made that can help GPHE address their inventory turnover that is currently suboptimal.

The first recommendation is to address the source of discontent between sales, product management, operations and sourcing. The source of discontent can be addressed with two mutually exclusive actions. GPHE should change their local sales commission model from only incentivizing margin on the sale to also include the newness of the product line. By doing so local sales will systematically push the new product lines. This will help the phase out old product lines that serve the same purpose as the new product lines. Followingly, old product lines can be phased out and demand can be concentrated out over a smaller assortment. This will help planning and increase inventory turnover. On top of this GPHE can also address their source of discontent by creating a common incentive for local sales and product management around the conversion rate. By doing so both functions will be keen to make sure that old product lines are phased out. Furthermore, this will drive collaboration and a knowledge share from product management to local sales about the new product lines and their technical specifications which have been described as a barrier to sales of new product lines. Altogether, this will help decrease the assortment size of parallel product lines and concentrating demand over fewer product lines and thereby decreasing the amount of obsolete products and the inventory needed for them.

The second recommendation to address the inventory turnover issue is to drive modularization. If GPHE further develop modularization into their products, they can achieve more design scalability from a smaller variation of components across their products. This will help them decrease their assortment size and counteract the creation of obsolete products. Furthermore, modularization fits well with the postponement structure that GCC and LA has and it is also in line with a responsive supply chain strategy that is considered the best fit for GPHE's operations. All in all, this will help GPHE handle their assortment size with a smaller pool of components and thereby enabling them to increase

their turnover and prevent an unfeasible inventory situation with a large amount of obsolete inventory.

6.4.2 Plan adherence

To address the current gap of poor plan adherence at GPHE, a recommended course of action is to implement a knowledge development initiative across the BU. This initiative should aim to enhance the overall understanding and awareness of the S&OP process among all employees who are directly or indirectly impacted by its outcome. By ensuring that everyone is aware that it is employed, familiar with the decisions that are made and the scenarios that are considered, it will facilitate improved adherence to the distributed plans. Moreover, this knowledge development initiative will provide valuable insights for employees not directly involved in the S&OP process, enabling them to contribute ideas for potential changes and improvements. To achieve this, it is proposed that they develop training materials that are distributed throughout the business unit, with specific sections designated as mandatory for selected employees. To maintain this increased level of knowledge they should also distribute information internally as to ensure that the knowledge and awareness remain at a high level, even after the novelty of the changes wears off.

To strengthen the increased level of plan adherence and to develop it even further, it is imperative that managers and employees who significantly impact the outcome of each iteration, deepen their knowledge and understanding even further. In addition to the general knowledge development initiative, these key stakeholders should obtain in-depth knowledge of the process, including how it can be tailored and customized to be better aligned with the present and future needs of the company. Moreover, it is crucial for them to be motivated and incentivized to drive this change. This select group of employees should actively be willing to try and immerse themselves in the opportunities and capabilities provided by a well-functioning process. This can be delivered by organizing lectures and seminars, or have experts come and host workshops. These learning experiences will allow these employees to gain an extended knowledge and expertise.

Finally, to fully utilize the newly acquired knowledge and maintain a culture of continuous improvement, it is recommended that Alfa Laval establish a forum dedicated for ideas and suggestions. This forum should serve as a platform where employees can contribute their thoughts for process improvement, particularly in customization and improvement. By providing a designated place for these discussions, everyone within the business unit can present their insights and ideas. From there, the managers should be responsible for evaluating and refining these ideas, considering their feasibility and how they can be implemented.

6.5 Academic and practical contribution

The main contributions of this thesis are considered twofold, practical, and theoretical. On a practical level, it provides contributions to Alfa Laval GPHE as it has its basis in examining, understanding, and improving their supply chain challenges. The main contributions of this thesis are the recommendations provided to GPHE for what they should do to better be able to realize the plan they agree upon in S&OP. These recommendations provide actions and objectives that directly help address GPHE's experienced gaps regarding inventory turnover and plan adherence. Since these recommendations are made with GPHE's organization and processes in mind, they are considered highly applicable and useful. Furthermore, these recommendations are generated from an analysis of how the integral functions of S&OP at GPHE can affect supply chain performance and what the cause of the experienced gaps could be. They are also considered contributions as the analysis raises the knowledge of supply chain management at GPHE and provides a root cause analysis of what elements contribute to their gaps.

This thesis contributes to theoretical understanding as is examines the challenges that manufacturing companies face when managing a supply chain. It illustrates how a structured organization with a dedicated process for creating a consensus plan still finds itself struggling with executing these plans. This exemplifies the complexities of supply chain management and creating alignment between actors. Furthermore, this thesis links inter-functional perspectives of an organization's supply chain to concrete issues experienced by management. By doing so this thesis provides a theoretical contribution as it explains, through supply chain management, how these issues are related to actions of functions in the GPHE business unit.

One aspect of academic value added to research is that of illustrating the complexity of implementing such a large process change such as an S&OP present to a company. Even for a large and mature company like as Alva Laval, which has invested much in trying to make sure that they follow what academic literature explains as best-case scenarios, success is not to be taken for granted. Current literature often portrays stories where the organization expects to find great success if they only follow what their written recipe for success. Meaning that if the organization implements the meetings, shares the right information, and measures the correct KPIs, the literature suggests that an efficient process will be resulting. Academic literature tends to not explain or illuminate the vast amount of hard work that also follows with the implementation.

6.6 Limitations

Perhaps the main limitation of this scope was the high-level strategy perspective of it. As the data was gathered qualitatively from the central management at GPHE, no inputs were given from the parts of the global organization which has a more hands-on responsibility for the processes. This could have caused the thesis to be skewed as only gaining inputs from management might not represent the full picture experienced by the entire organization. Furthermore, more data and input from employees closer to the processes could also have been beneficial for the analysis. However, even if this could be seen as a limitation from some perspective, it would make the scope of the thesis too broad and general to consider data and specific issues from employees working more directly with the supply chain processes in the BU at large.

Another limitation that was experienced was the time frame. Due to the 20-week duration of the thesis, methodological constraints were experienced that could have been resolved with a longer time horizon. As the S&OP process is of interest in this thesis and it has an iterative cycle of one month, a longitudinal approach could have been a more appropriate way of studying the issue. This would enable a deeper understanding of iterations and how inputs are interpreted into plans. By observing this, insights might be gained into more reasons that contribute to the inefficiencies that arise when GPHE realizes its plans. In this thesis, data was obtained through interviewers' perception of problems and historical actions. Following the process and the potential issues firsthand could be beneficial for the result of the study. Furthermore, a longitudinal study would also enable a look at the implementation aspect of the recommendations. This would be beneficial for GPHE to see if the recommendations are feasible and help the experienced issues. As a result, a more in-depth and holistic conclusion of the study could be obtained.

Lastly, the thesis was designed to qualitatively examine the experienced issues at GPHE. This decision was made to capture a more general systematic overview of the BU. However, it is identified that including a model or a numerical analysis would further strengthen the analysis and recommendations. Firstly, as it pinpoints quantitatively what problems that are experienced. Secondly, a quantitative model could also help show how recommendations could lead to a change of certain variables that ultimately impact performance.

6.7 Future research

One area of study which would be of interest in the context of this thesis is the aspect of matching the sales forecast with operations planning. At GPHE there were concerns raised about the translation of the sales forecast to a supply plan. As aspects such as software and systems were a limitation in this thesis, it was not addressed, but for future research, it would be useful to study how this conversion could be improved for this specific case or similar ones. Converting sales figures to manufacturing plans has proven to be a difficult task as their products contain a lot of components. This difficulty is further increased as they can only be made at select locations around the world. A development on this subject would be of great benefit to GPHE, as the currently employed process is time-consuming and difficult. This would presumably also be useful for the industry sector at large.

Another question of future research that this thesis raises is that of improving supply chain performance while also showing consideration for a sustainability strategy. In this thesis, the sustainability strategy of GPHE was not considered. However, it was noticed that in some intervieews' discussions were limited as decisions or actions had been based on a sustainability agenda. In this thesis, much of the analysis focuses on improving supply chain performance in line with the strategy at GPHE, however, no consideration of the sustainable agenda is regarded. A sustainability strategy does include tradeoffs with supply chain performance. For instance, a local supplier might be beneficial in terms of CO2 emissions, but more costly. Future research on the topic of improving supply chain performance without contradicting sustainability targets would be useful and beneficial not only to Alfa Laval but also to other manufacturing companies with a sustainability strategy or agenda.

References

Alfa Laval, 2023. *www.alfalaval.se.* [Online]
Available at: https://www.alfalaval.com/products/heat-transfer/plate-heat-exchangers/gasketed-plate-and-frame-heat-exchangers/industrial-line/
[Accessed 31 March 2023].

Anupindi, R. et al., 2012. *Managing Business Process Flow.* 13th ed. New Jersey: Pearson Education Inc..

Axsäter, S., 2006. *Inventory Control.* 2nd Edition ed. New York: Springer Science & Business Media, LCC.

Ballou, R. H., 2006. Revenue estimation for logistics customer service offerings. *The international Journal of Logistics Managment,* 17(1), pp. 21-37.

Bennet, A., 2015. Case Study: Methods and Analysis. In: *International Encyclopedia of the Social & Behavioral Sciences.* Georgetown University, Washington, DC, USA: Elsevier Ltd, pp. 208-213.

Blackstone, J. H., 2010. *APICS Dictionary.* 13th ed. Chicago: APICS.

Bonney, M. C., 1994. Trends in inventory managment. *International Journal of Production Economics,* 34(1-3), pp. 107-114.

Boorman, J., 2013. S&OP: Five Steps to Gaining Necessary and Appropriate Buy-In. *Foresight: The International Journal of Applied Forecasting,* Winter2013(28), pp. 37-42.

Bozarth, C. C. & Handfield, R. B., 2019. *Introduction to Operations and Supply Chain Management.* 5th ed. Harlow: Pearson Ecuation Limited.

Calder, B. J., Phillips, L. W. & Tybout, A. M., 1982. The Concept of External Validity. *Journal of Consumer Research,* Vol. 9(No. 3), pp. 240-244.

Chandra, C. & Grabis, J., 2008. Inventory management with variable lead-time dependent procurement cost. *Omega,* 36(5), pp. 877-887.

Chopra, S. & Meindl, P., 2013. *Supply Chain Management: Strategy, Planning and Operation.* 5th Edition ed. New Jersey: Pearson Education, Inc..

Christopher, M., 2000. The Agile Supply Chain: Competing in Volatile Markets. *Industrial Marketing Management,* 29(1), pp. 37-44.

Closs, D. J., Jacobs, M. A., Swink, M. & Webb, S. G., 2008. Toward a theory of competencies for the managmeent of product comlexity: Six case studies. *Journal of Operations Management,* 26(1), pp. 590-610.

Closs, D. J., Nyaga, G. N. & Voss, D. M., 2010. The differential impact of product complexity, inventory level, and configuration capacity on unit and order fill rate performance. *Journal of Operations Management,* 28(1), pp. 57-57.

Cooper, M., Pagh, J. & Lambert, D., 1997. Supply Chain Management: More Than a New Name for Logistics. *The International Journal of Logistics Management,* Vol. 8(No. 1), pp. 1-14.

de Oliveira Pedra Romão, L., Scavarda, L. F. & Machado, E., 2022. Sales & Operations Planning a Practical Implementation Guide. *Production and Operations Management*, vol 391 October, Volume Vol 391, pp. pp 21-32.

DeSmet, B., 2021. *The Strategy-Driven Supply Chain: Integrating strategy, finance and supply chain for a competitive edge.* London, United Kingdom: Kogan Page Limited.

Enyi, P., 2005. How Useful is the Return of Capital Employed (ROCE) as a Performance Indicator?. *AJMS,* 1(4th).

Fisher, M., 1997. What is the right supply chain for your product?. *Harvard Business Review,* Vol. 75(No. 6), pp. 105-160.

George, A. L. & Bennet, A., 2005. *Case Studies and Theory Development in the Social Sciences.* 1st ed. Cambridge, Mass: MIT Press.

Giddens, A. & Sutton, P. W., 2021. *Sociologi.* 6 ed. s.l.:Studentlitteratur AB.

Grimson, A. J. & Pyke, D. F., 2007. Sales and operations planning: an explatory study and framework. *The international Journal of Logistics Management,* 18(3), pp. 322-346.

Gunasekaran, A. & Ngai, E. W. T., 2005. Build-to-order supply chain management: a literature review and framework development. *Journal of operations management,* 23(5), pp. 423-451.

Hayes, R. H. & Wheelwright, S. C., 1984. *Restoring our Competitive Edge - Competing Through Manufacturing.* 1 ed. New York: Wiley.

Hsuan Mikkola, J. & Skjott-Larsen, T., 2004. Supply-Chain Integration: Implications for mass customization, modularization and postponement strategies. *Production Planning & Control,* 15(4), pp. 352-361.

Huang, Y.-Y. & Li, S.-J., 2008. Suitable application situations of different postponement approaches: Standardizations vs. modularization. *Journal of manufacturing systems,* 27(3), pp. 111-122.

Inman, R. R., 1993. Inventory is the flower of all evil. *Production Inventory Managment Journal,* 34(4), pp. 41-45.

Johnson, M. & Templar, S., 2011. The relationship between supply chain and firm performance. The developing and testing of a unified proxy.. *International Journal of Physical Distribution and Logistics Management,* 41(2), pp. 88-103.

Kothari, C. R., 2004. *Research Metodology.* 2nd Edition ed. New Delhi: New Age International (P) Ltd., Publishers.

Lapide, L., 2004. Sales And Operations Planning Part II: Enabling Technology. *The Journal of Business Forecasting Methods & Systems,* 23(1), p. 18.

Marek, S., Schuh, G. & Stich, V., 2020. Identification of multidimensional key performance indicators for manufacturing companies. *IEEE Technology and Engineering Management Conference,* Volume 2020, pp. 1-6.

Mattson, S.-A. & Jonsson, P., 2009. *Manufacturing Planning and Control.* London: McGraw Hill.

Mattsson, S. & Jonsson, P., 2003. *Produktionslogistik.* 1:8 ed. s.l.:Studentlitteratur.

Mello, J., 2010. Corporate Culture And S&OP: Why Culture Counts. *Foresight: The International Journal of Applied Forecasting,* Jan2010(16), pp. 46-49.

Mentzer, J., 2004. *Supply Chain Management.* s.l.:SAGE Publication,s Inc..

Mentzer, J. T. et al., 2001. Defining Supply Chain Management. *Journal of Business Logistics,* 22(2), pp. 1-25.

Mukopi, C. M., 2015. An Analysis of the Effects of Inventory Management on the Performance of the Procurement Function of Sugar Manufacturing Companies in the Western Kenya Sugar Belt. *International Journal of Scientific Research Publications,* 5(5), pp. 809-822.

Nakano, M., 2020. *Supply Chain Management. Strategy and Organization.* 1st ed. Singapore: Springer.

O'Leary-Kelly, S. W. & Vokurka, R. J., 1998. The empirical assessment of construct validity. *Journal of Operations Management,* November, Vol. 16(No. 4), pp. 387-405.

Olhager, J., Rudberg, M. & Wikner, J., 2001. Long-term capacity mangement: linking the perspective from manufacturing strategy and sales and operations planning. *International Journal of Production Economics,* 69(2), pp. 215-222.

Porter, M. E., 1996. What is strategy?. *Harvard Business Review,* Vol. 74(No. 6), pp. 61-78.

Rachad, S., El Idrissi Larabi, Z., Nsiri, B. & Bensassi, B., 2017. Inventory Management in Closed Loop Structure Using KPIs. *International Journal of Applied Engineering Research,* 12(15), pp. 4864-4869.

Reige, A. M., 2003. Validity and reliability tests in case study research: a literature review with “hands-on” applications for each research phase. *Qualitative Market Research,* Vol. 6(No. 2), pp. 75-86.

Rowley, J. & Frances, S., 2004. Conducting a Literature Review. *Management Research News,* Vol. 27(No. 6), pp. 31-39.

Rummler, G. A. & Brache, A. P., 1991. Managing the White Space. *Training,* 28(1), pp. 55-70.

Runeson, P. & Höst, M., 2009. Guidelines for conducting and reporting case study research in software engineering. *Empirical Software Engineering,* 14(2), pp. 131-164.

Saunders, M., Lewis, P. & Thornhill, A., 2012. *Research Methods for Business Students.* 6th ed. Essex: Pearson Education Ltd.

Scott, C., Lundgren, H. & Thompson, P., 2011. *Guide to Supply Chain Managmenet. An End to End Perspective.* 2nd edition ed. Berlin: Springer.

Selldin, E. & Olhager, J., 2007. Linking products with supply chains: testing Fisher's model. *Supply Chain Management,* Vol. 12(No. 1), pp. 42-51.

Shah, N. H. & Mittal, M., 2020. *Optimization and Inventory Management.* 1st ed. Singapore: Springer.

Simatupang, T. & Sridharan, R., 2005. Supply chain discontent. *Business Process Management Journal,* 11(4), pp. 349-369.

Simichi-Levi, D., Kaminsky, P. & Simichi-Levi, E., 2000. *Designing and Managing The Supply Chain. Concepts, Strategies and Case Studies.* 1st ed. USA: McGraw-Hill Higher Education.

Song, J.-S., Van Houtum, G.-J. & Van Mieghem, J. A., 2020. Capacity and Inventory Management: Review, Trends, and Projections. *Manufacturing and Service Operations Management,* 22(1), pp. 36-46.

Stalk, G. J., 1988. Time: The Next Source of Competitive Advantage. *Harvard Business Review,* 66(July-August), pp. 41-51.

Stentoft, J., Rajkumar, C., Vagn Freytag, P. & Stegmann Mikkelsen, O., 2020. Sales and operations planning: empirical insights into percived relevance and lack of implementation. *Supply chain forum: An international journal,* 21(4), pp. 246-259.

Swain, J. A., Maloni, M., Bower, P. & Mello, J., 2016. Antecedents to effective sales and operations planning. *Industrial Management & Data Systems,* 116(6), pp. 1279-1294.

Swink, M. & Schoenherr, T., 2014. The Effects of Cross-Functional integration on Profitability, Process Efficiency, and Asset Productivity. *Journal of Business Logistics,* 36(1), pp. 69-87.

Tavares, T. A. M., Scavarda, L. F., Fernandez, N. S. & Scavarda, A. J., 2012. Sales and Operations planning: A research synthesis. *International Journal of Production Economics,* 138(1), pp. 1-13.

Tersine, R. J. & Hummingbird, E. A., 1995. Lead-time reduction: the search for competitive advantage. *International Journal of Operations Production Management,* 15(2), pp. 8-18.

Toomey, J. W., 2000. *Inventory Managment: Principles, Concepts and Techniques.* 1st ed. New York: Springer Science+Business Media.

Treacy, M. & Wiersema, F., 1995. *The discipline of market leaders: choose your customers, narrow your focus, dominate your market..* USA: AddisonWesley.

Tuomikangas, N. & Kaipia, R., 2014. A coordination framework for sales and operations planning (S&OP): Synthesis from the literature. *International Journal of Production Economics,* Volume 154, pp. 243-262.

Ulrich, k. & Tung, K., 1991. *Fundamentals of Product Modularity.* Atalanta, Proceedings of the 1991 ASME Winter Annual Meeting Symposium on Issues in Design/Manufacturing.

Van Hove, N., 2017. How to Shape a Company Culture with S&OP. *Foresight: The International Journal of Applied Forecasting,* Spring2017(45), pp. 43-48.

Vereecke, A., Vanderheyden, K., Baecke, P. & Van Steendam, T., 2018. Mind the gap - Assessing maturity of demand planning, a cornerstone of S&OP. *International Journal of Operations & Production Management,* 38(8), pp. 1618-1639.

Yin, R. K., 2018. *Case Study Research and Applications: Design and Methods.* 7th ed. Los Angeles: SAGE Publications Ltd..

Yu-Lee, R. T., 2002. *Essentials of Capacity Management.* 1 ed. New York: John Wiley & Sons, Inc..

Zahedi, M., Abbasi, M. & Khanachah, S. N., 2020. Provide a lean and agile supply chain model in project-based organizations. *Annals of Management and Organization Research*, pp. 213-233.

Appendix A

Data collection protocol

Section A – Overview of Case Study

Hi,

We are Jacob Knutsson and Theodor Jener, two engineering students from LTH currently pursuing our master's in supply chain management. For the duration of the following couple of months, we will write our master's thesis with you here at Alfa Laval.

The title of our thesis:

Supply Chain Management: Increasing Performance and Coordination in a Sales & Operations Planning Context

The purpose of this thesis is to increase total coordination, performance, and strategic alignment of the S&OP process and its integral functions at Alfa Laval GPHE. We want to analyze, understand, and improve how and why plans decided upon in the S&OP are not fully realized. We will analyze strategies and goals of the business process, but also the S&OP process and how functions integral to the process operates.

We aim to answer the following research questions:

- *RQ1: How can integral business functions of S&OP impact supply chain performance?*
- *RQ2: What can be the cause of gaps between GPHE's S&OP plan and outcome?*
- *RQ 3: What can the integral business functions of GPHE's S&OP do to be better aligned with strategic targets?*

We would like to thank you for considering participating in the interview. It is an important data collection phase that ensures the applicability of the results from our master thesis to you at Alfa Laval, and we value your contribution.

So, what now?

- Please accept this meeting invitation if you wish to attend.
- If you cannot attend this interview, please suggest alternative availability and we will do our best to accommodate you.
- We would prefer to have this meeting face-to-face but if this is not an option, please let us know and we will adjust accordingly.
- Let us know if your circumstances have changed, and you no longer wish to attend the interview.

We look forward to meeting you, please reach out to either of us if you have any questions or concerns.

Best regards,

Jacob Knutsson, jacob.knutsson@alfalaval.com

Theodor Jener, theodor.jener@alfalaval.com

Section B – Data Collection Procedures

In the data collection phase of our research, we aim to interview stakeholders from several business functions at Alfa Laval GPHE. We hope to get answers from S&OP, Operations, Sales, sourcing and product management to mention some. The data we aim to collect will revolve around general, organizational, and strategic work that you perform and what decisions you and your function is responsible for. The primary evidence that we are expecting to obtain from these interviews are mainly your observations and thoughts.

The answers you provide during the interview will be collected and matched with answers from your colleagues. From there we will analyze the data to get a deeper understanding of the long and short-term operations of Alfa Laval. We will identify key issues from the provided data as well as give a holistic analysis of the current state of the business unit, within the scope of our research. From there, we will create a framework based on theory and customize it to be applicable for the specific scenario of Alfa Laval.

We will also have an interactive exercise with all the interviewees where we will ask you to give scores to three different categories. Both from an organizational perspective and from the perspective of your business function.

We do not expect or require you to prepare in any way for the interview, other than reading this document. Any or all your answers can be anonymized on request, and we will never publish any names in the final report.

Section C – Protocol Questions

General questions

For how long have you been working with Alfa Laval?

Have you been working with any other Business functions prior to your current role?

Describe your role and responsibilities?

Describe your business function's role and responsibilities?

Organizational questions

What processes are your team responsible for?

How do they work?

How does your business function collaborate with other functions at Alfa Laval?

What do you need from other business functions to perform your job?

- Do you think the collaboration is at a satisfactory extent?
- Is there any function in which the collaboration is functioning particularly well/poor?

Do you experience any issues with the current organizational set up?

- What do think these issues are?
- Are you working actively to resolve them?

S&OP (if applicable)

What are your business function's roles and responsibilities in the S&OP sessions?

If not, do you think your function affects the S&OP in any way

What preparatory work do you perform before the S&OP sessions?

How do you present this work/data?

Which data do you think impact the decisions/meeting outcomes the most?

Which business function do you think has the most influence on the sessions' decisions/meeting outcomes?

How does your business function collect and review the implementation/success of the decisions?

Strategy

How do you interpret the overall strategy to your business function and how does that affect your work?

What KPI's/targets are you measuring?

How are you tracking the performance?

What KPI's do you think are important/unnecessary?

Do you think there are any additional KPIs that you could benefit from?

I.e. To present your performance better?

What are your targets and goals?

Do you experience any constraints to achieving your goals?

Do you see any potential room for improvement in how you collaborate with other business functions?

Distribute 10 points between the corners of this triangle based on what you think is the most important to achieve your goals: