Enhancing Supply Chain Visibility and Coordination through a Control Tower

A Case Study at Lindab

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Abstract

Title: Enhancing Supply Chain Visibility and Coordination through a Control Tower: A Case Study at Lindab

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

Problem Formulation: Managing a supply chain efficiently is a complex task that requires taking many parameters into consideration. Lindab is an international company with sites located across a large part of Europe and operates within a highly complex supply chain involving multiple production stages. In addition, coordination is difficult to achieve due to the company's decentralized organizational structure. This results in a noticeable and quantifiable outcome: transportation inefficiencies. To address this situation, Lindab is considering the implementation of a Control Tower (CT) within its supply chain in order to obtain a centralized view capable of coordinating and improving the efficiency of the logistics network.

Purpose: The purpose of this thesis is to evaluate whether Lindab should move forward with the implementation of a Control Tower, and to identify the main benefits, barriers, and conditions required for its success.

Research Questions:

- RQ1: What structural and operational inefficiencies characterize Lindab's current supply chain?
- RQ2: How can a Control Tower contribute to improving visibility, coordination, transport efficiency, and inventory management within Lindab's decentralized supply chain?
- RQ3: What is the business case for implementing a Control Tower at Lindab, and what organizational and technical conditions must be met for it to deliver value?

Methodology: Given the exploratory nature of this study, which aims to assess the feasibility of implementing a CT within Lindab, a case study approach was chosen. This approach allowed for a detailed examination of the phenomenon within Lindab's existing operations. The study used a mixed-method strategy, combining both qualitative and quantitative data insights. Qualitative data was gathered through interviews with key stakeholders and quantitative from internal databases.

Conclusions: Given the benefits identified, such as improved supply chain visibility, enhanced transport coordination, higher transportation efficiency and better inventory management capabilities, Lindab could be more cost and operational efficient if the CT implementation continues and is therefore recommended to continue developing this initiative. In this regard, the PoC conducted across Sweden, Norway, and the United Kingdom demonstrated clear benefits even under highly manual conditions, validating the recommendation. Also, it is proposed a gradual rollout strategy, beginning with the consolidation of the Central and Regional CT in Sweden then expanding to a second Central CT in Czech Republic and lastly the rollout of Regionals CTs.

However, this recommendation is subject to certain conditions. The organizational complexity, decentralized structure, data quality and integration of systems challenges identified throughout the study must be acknowledged. To succeed, Lindab needs to ensure strong internal alignment between entities, improve master data, harmonize ERP systems, and establish effective change management processes.

Keywords: Supply Chain Control Tower, Supply Chain Visibility, Transport Consolidation, Decentralized Supply Chain, Logistics Coordination, Master Data Governance, Change Management, Proof of Concept, Inventory Optimization.

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Lund, May 2026
Zaira Arenas Borrego
Henar García del Val

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List of Abbreviations

AI Artificial Intelligence.

CT Control Tower.

DL Domestic Local.

ERP Enterprise Resource Planning.

GC Group Central.

IMS Inventory Management System.

IoT Internet of Things.

KPI Key Performance Indicator.

MO Manufacture Order.

PO Purchase Order.

POC Proof of Concept.

RC Regional Central.

RQ Research Question.

SC Supply Chain.

SCM Supply Chain Management.

SCV Supply Chain Visibility.

SLA Service Level Agreements.

SO Sales Order.

Steel Steel slitting centres.

TMS Transport Management System.

TO Transfer Order.

WMS Warehouse Management System.

Glossary

Artificial Intelligence (AI) A field of computer science concerned with developing systems capable of performing tasks that normally require human intelligence, supporting advanced analytics and decision-making in logistics and CTs.

Control Tower (CT) A centralized structure within the supply chain that monitors, coordinates, and optimizes logistics and operational processes, enabling improved visibility, identification of disruptions, coordinated corrective actions, and faster decision-making.

Domestic Local (DL) Role of the sites representing the final level of the logistics network, primarily serving local markets. DL delivers stocked products to customer warehouses, construction sites, or for pick-up, and sometimes produces large products such as ducts locally as well as handling orders from the GC and RC. Systems include Transport Management, Inventory Management, Order Management, Customer Relationship Management and Sales platforms.

Enterprise Resource Planning (ERP) An integrated software system used to manage core business processes such as finance, procurement, production, and inventory.

Group Central (GC) Role of the sites focusing on highly automated production of smaller products, acting as main suppliers to Regional Central sites. GC serve as large warehouses, optimizing transport with high fill rates, and manage systems like WMS, TMS, IMS, and Lindab Production System..

Internet of Things (IoT) A network of interconnected devices and sensors that collect and transmit real-time data, which can support enhanced supply chain visibility and responsiveness through integration with the CT.

Inventory Management System (IMS) A software system used to monitor, control, and optimize inventory levels and stock movements.

Key Performance Indicator (KPI) A measurable metric used to evaluate the performance and effectiveness of supply chain processes, which can be monitored through the CT to assess operational performance.

Manufacture Order (MO) A document authorizing and detailing the production of goods, including the materials, quantities, and operations required for manufacturing.

Proof of Concept (POC) A small-scale demonstration conducted to assess the feasibility and expected benefits of implementing a solution or new system.

Purchase Order (PO) A document issued by a buyer to request goods or services from a supplier, specifying quantities, prices, and delivery terms.

Regional Central (RC) Role of the sites focusing on manual production of larger products, acting as main warehouses for local markets. RC supply Domestic Local sites on fixed routes, manage stocked items from external vendors, and optimize truck operations, using systems like TMS, IMS and WMS.

Sales Order (SO) A document confirming a customer's order for goods or services, including quantities, prices, and delivery details.

Steel slitting centres (Steel) Role of the sites that function as slitting centres, providing raw material to the company's production sites. This includes the company site with this role located in Bjäre, as well as external slitting centres that supply other production sites not covered by the former.

Supply Chain (SC) The network of organizations, activities, and resources involved in producing and delivering products to customers, which can be coordinated and optimized through a CT approach.

Supply Chain Management (SCM) The planning and management of sourcing, procurement, production, and logistics activities with the aim of maximizing efficiency and value, where a CT can enhance monitoring and coordination.

Supply Chain Visibility (SCV) The ability to track and monitor products, inventory, and orders across the supply chain in real time, representing a key benefit of implementing a CT.

Transfer Order (TO) A document issued to authorize and manage the transfer of goods or materials between warehouses, specifying quantities, source and destination locations, and transfer instructions.

Transport Management System (TMS) A software system used to plan, execute, and optimize transportation operations, which in this thesis is considered as a system integrated with the CT to support improved decision-making.

Warehouse Management System (WMS) A software system designed to manage and optimize warehouse operations, including inventory control, storage, and order processing. When integrated with the CT, it provides real-time operational data that enhances visibility and coordination across Lindab's supply chain.

1 Introduction

This chapter provides a structured overview of the master's thesis. It begins by presenting the background of the research domain and a detailed description of the company under study. Subsequently, the problem formulation, the purpose of the research and the guiding research questions are outlined. The chapter further discusses the delimitations and the relevance of the study, before concluding with an outline of the overall report structure.

1.1 Background

The increasing globalization of markets has led to highly complex supply chains that must coordinate a wide range of actors, activities, resources and information flows across geographical boundaries. While this globalization has enabled cost efficiencies and access to broader markets, it has also exposed supply chains to significant challenges such as demand volatility, geopolitical uncertainty and climate-related disruptions (Nadar et al., 2025). At the same time, companies face growing pressure to improve profitability and reduce operational costs, which reinforces the need for advanced tools capable of supporting informed and timely decision-making (Trzuskawska-Grzesińska, 2017).

Supply Chain Management (SCM) can be defined as the coordination of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at the lowest possible cost for the entire supply chain (Christopher, 2011). Over recent decades, effective SCM has become increasingly challenging due to factors such as product variety expansion, shorter product life cycles, higher levels of outsourcing, global dispersion of operations and rapid advances in information technologies (Lee, 2002). In this context, the emergence of Industry 4.0 technologies, including the Internet of Things (IoT) and Artificial Intelligence (AI), offers new opportunities to enhance efficiency, agility and resilience while improving the utilization of resources across supply chains (Fatorachian & Kazemi, 2021; Ivanov et al., 2021).

One of the most persistent challenges in SCM remains uncertainty in both supply and demand, which increases the need for enhanced visibility and control mechanisms (Trzuskawska-Grzesińska, 2017). Supply Chain Visibility (SCV) refers to the ability to capture, integrate and analyze data across the supply chain in order to support speed, reliability and flexibility in decision-making (G. Bhosle et al., 2011). Within this framework, Control Towers (CTs) have emerged as an approach to centralize monitoring, analysis and coordination across end-to-end supply chain processes. By continuously monitoring transportation flows, inventory movements and operational performance, CT enable organizations to detect disruptions early, respond proactively to deviations and strengthen supply chain resilience and agility (Alias, Goudz, et al., 2015; G. Bhosle et al., 2011; Fonseca, 2025; Li, Miskon, Jamal, et al., 2024).

Against this background, companies with geographically dispersed production and distribution networks face increasing complexity in coordinating logistics operations efficiently. Lindab, a leading European company within ventilation and building systems, operates across multiple countries and manages a complex logistics network that requires high levels of coordination and transparency (Lindab, 2025).

In response to these challenges, Lindab has begun exploring the potential benefits of implementing an internal CT to improve supply chain visibility, operational efficiency and sustainability performance.

As an initial step, Lindab carried out a proof of concept (PoC) for a CT, focusing on deliveries from the production sites in Bjäre, Sweden, to Lindab Sweden, Lindab UK, and Lindab Norway. This PoC started in 2024 and has gradually been consolidated over time. The achieved benefits, extrapolated to an annual basis, amount to approximately 1,200,000 SEK. These results highlight the potential value of centralized logistics coordination and serve as an empirical foundation for further investigation.

Building on this context, this thesis examines the potential benefits of implementing a CT at a larger scale within Lindab, with the objective of assessing its value in addressing operational challenges, improving SCV and performance, and enabling data-driven decision-making.

1.2 Company Description

Lindab is an international building products company with more than 60 years of history. Its origins go back to a small sheet metal workshop founded in Lidhult, Sweden in 1956, which was formally established in Grevie three years later. During the mid 1960s, the company adopted the name Lindab, marking the start of its transition from a local manufacturer to an international industrial group. Today Lindab operates in 19 European countries and has become a key player in the building products sector, especially in ventilation solutions. The company's main business focuses on ventilation system solutions, complemented by a range of building products such as roofing and wall systems. Lindab's vision is "to be the leading player in the area in which we are strongest – ventilation in Europe" and its purpose emphasizes creating a better indoor climate while contributing to a sustainable environment.

The company employs around 5,000 people and is present in approximately 180 locations across Europe, continuing to grow through targeted investments, operational improvements and innovation initiatives. From a financial perspective, Lindab reported net sales of 12,854 million SEK in 2025, a decrease of 4 percent compared to the previous year, reflecting a challenging market environment across Europe. Sales are distributed across three main regions: Western Europe (45%), the Nordic region (41%) and Central Europe (10%), with the remaining 4% in other markets.

1.2.1 Business Areas

Lindab is organized into two main business areas, each with multiple production plants spread across different countries.

Lindab Ventilation is the company's largest business area, driving most of Lindab's technical expertise and generating the majority of (79%) sales. It focuses on the production, development, and innovation of ventilation materials and systems, which form the core of Lindab's offering. Meeting customer demand efficiently requires careful coordination between production, inventory, and delivery.

Lindab Profile focuses on the production and development of building materials, including roofing, wall systems, and other structural products, representing around 21% of Lindab's total sales. Many of these products are customized to local market requirements, which makes production scheduling and distribution more complex.

These two business areas are mainly supplied with steel by the **Steel Slitting Centres (Steel)**, which sources raw material from steel mills and, through a pre-processing operation where the steel is slit, provides raw materials to the majority of the production sites.

Although the group has overall strategic objectives, the company follows a decentralized structure, each site operates largely on its own, making decisions independently. This high level of autonomy adds complexity to Lindab's global supply chain and makes logistics planning and coordination a real challenge. This lack of coordination shows innefficiencies mainly in truck fill rates, with potential for improvement in load utilization, especially for large or bulky products, which sometimes leads to trucks carrying mostly air. Coordination between plants and countries is limited, with duplicate transport efforts and an increase of costs and environmental impact. On other hand, demand is generally stable, but last-minute orders happen occasionally, especially when construction projects require urgent deliveries. This often means adjusting safety stock levels to meet delivery times, adding another layer of complexity.

1.2.2 Supply Chain

Lindab's supply chain is complex and multi-level, with sites organized into distinct roles: Steel Mills, Steel, Group Central (GC), Regional Central (RC), Domestic Local (DL), and External Suppliers. Each level has specific responsibilities in production, distribution and customer service, forming a coordinated internal logistics system that spans from raw materials to the end customer. To better understand and manage this structure, Lindab classifies products according to where they are produced and sourced within the network, linking each product to the corresponding supply chain role.

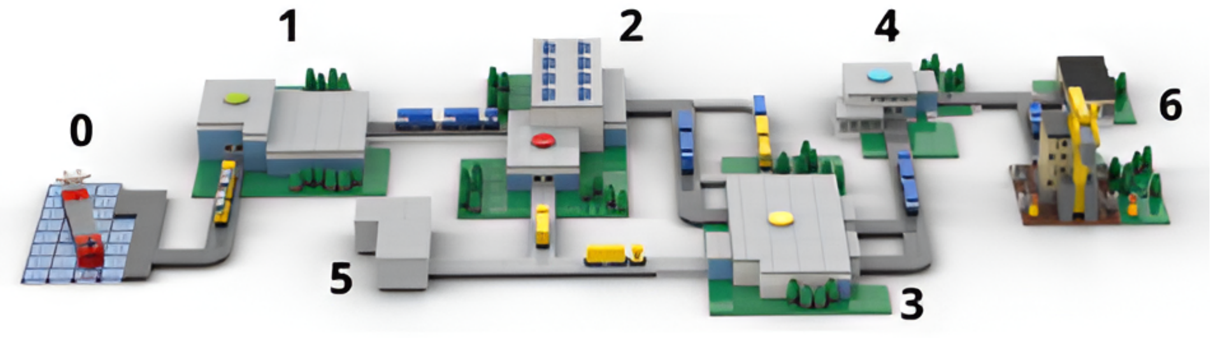


Figure 1: Supply chain model of Lindab

0. Steel Mills

Steel Mills purchase ore and produce steel coils, which are delivered on long lead times. Delivery precision is measured in weeks and volumes are contracted quarterly in advance. Steel Mills supply Lindab with the raw material needed for production and are the largest sourcing segment, representing approximately 2.5 billion SEK. The company works with five major suppliers to source around 220,000 tons of steel annually, some of which is delivered directly to production sites while the rest goes through Lindab Steel for central processing.

1. Steel

The Steel unit acts as the central purchasing hub for all steel needs. It handles direct deliveries to Lindab units and supplies raw or semi-processed materials for production. Products are largely made to order and batch-controlled. This unit also includes external steel slitting centres, such as those in the UK, when freight from the central slitting facility is not feasible. The site uses TMS, advanced production planning tools and vendor-managed inventory to track orders, transfers and deliveries.

2. Group Central (GC)

There are 4 sites that have this role and they act as main suppliers of core products to downstream sites. Group Central sites focus on highly automated production of smaller product dimensions and they also function as large warehouses of a great amount of products. Systems at this level include WMS, IMS, TMS, intercompany product configuration and Lindab Production System.

3. Regional Central (RC)

There are around 20 sites that have this role, focus on manual production of larger products like segmented bends and act as main warehouses for local markets and as a regional center. They supply Domestic Local sites on fixed routes to ensure product availability and short lead times. These centers also manage stocked items from external vendors and optimize their own truck operations with back-hauling. Systems include TMS, IMS, WMS and transfer and purchase order controls.

4. Domestic Local (DL)

Domestic Local sites, around 120 in total, represent the final level of the logistics network. They primarily serve as small warehouses to local markets, delivering stocked products to customer warehouses, construction sites, and acting as walk-in stores in some markets. Some Domestic Local sites also produce ducts locally. These sites deliver products to final customers. Systems include TMS for route planning and last mile, IMS, Customer Relationship Management and Sales platforms. These sites handle a large volume of orders, serve nearly 20,000 customers and manage tens of thousands of unique items.

5. External Suppliers

External suppliers, numbering about 10,000, provide traded goods, packaging, insulation and other direct materials for production that Lindab does not produce internally. They can deliver to Group Central, Regional Central, Domestic Local sites and final customer, while Lindab retains control of the internal distribution network.

6. Customers

Customers represent the final stage of Lindab's supply chain and are responsible for purchasing and installing finished products. The main customer segments include installers, Original Equipment Manufacturers (OEMs), wholesalers, and construction companies, each with different delivery and service requirements. Customers place orders through several channels including sales platforms production selection software web shops and Electronic Data Interchange. These interfaces connect customer demand directly with Lindab's production planning distribution and transport activities making customers a key driver of volumes lead times and logistics complexity across the network.

Finally, it is important to highlight that Lindab's logistics operations are limited to the internal distribution network, spanning from Steel, GC, RC, DL, and ultimately to the customer. In other words, Lindab does not control the logistics of delivering steel to its sites or the transportation of traded products sourced from external suppliers. This internal focus allows the company to optimize its own supply flows and service performance, while the inbound logistics from suppliers remain outside its direct management.

The complexity of the company's supply chain can be observed in the following Figure 2.

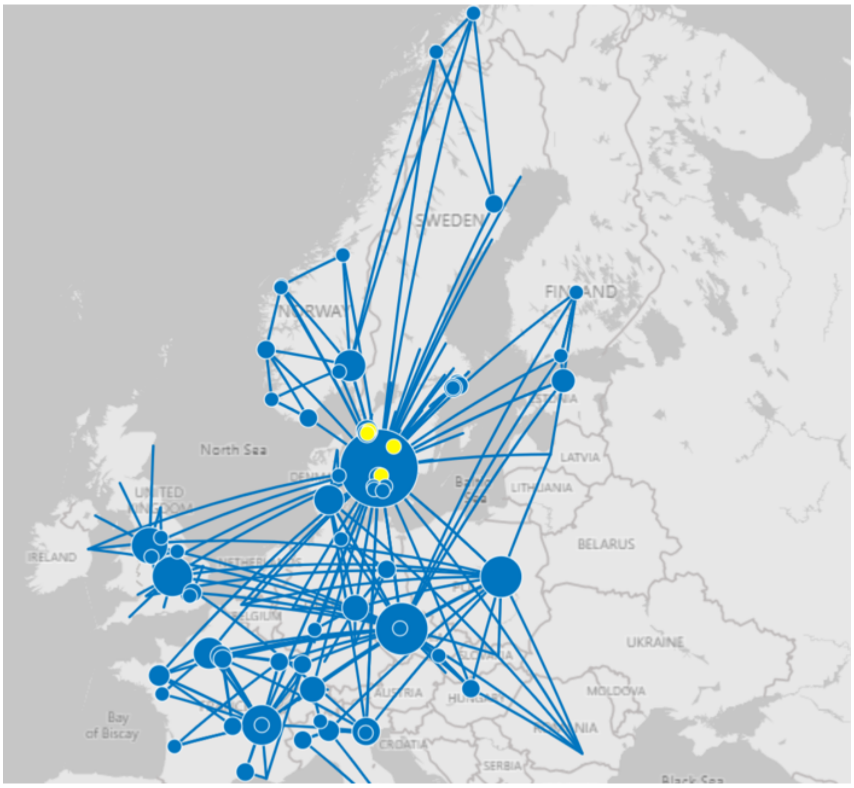


Figure 2: Lindab Supply Chain overview

1.2.3 Operational Flow

As described above, Lindab's supply chain consists of multiple stages of processing and distribution connecting different levels of production. A key characteristic of this network is that each site operates both as a supplier and as a customer: sites receive goods from other Lindab locations while simultaneously shipping to others, creating a system of interconnected supplier-customer relationships rather than a simple linear flow.

For items already available in stock, Ventilation and Profile sites operate with relatively short and predictable lead times. In these cases, On Day 0 DL receives and registers the POs, and on Day 2 the goods are ready to be dispatched, reflecting a make-to-stock environment.
In contrast, standard production items follow longer and more structured timelines. Steel operates with an average lead time of 5 days from PO receipt to shipment. Similarly, Ventilation production orders generally require between 5 and 6 days before being ready for dispatch. These extended lead times account for production activities, internal handling, and coordination across the site.
For special or custom items, lead times are less standardized and tend to be significantly longer across all sites. Depending on product complexity and material availability, these orders typically require around 1 week or more before shipment.

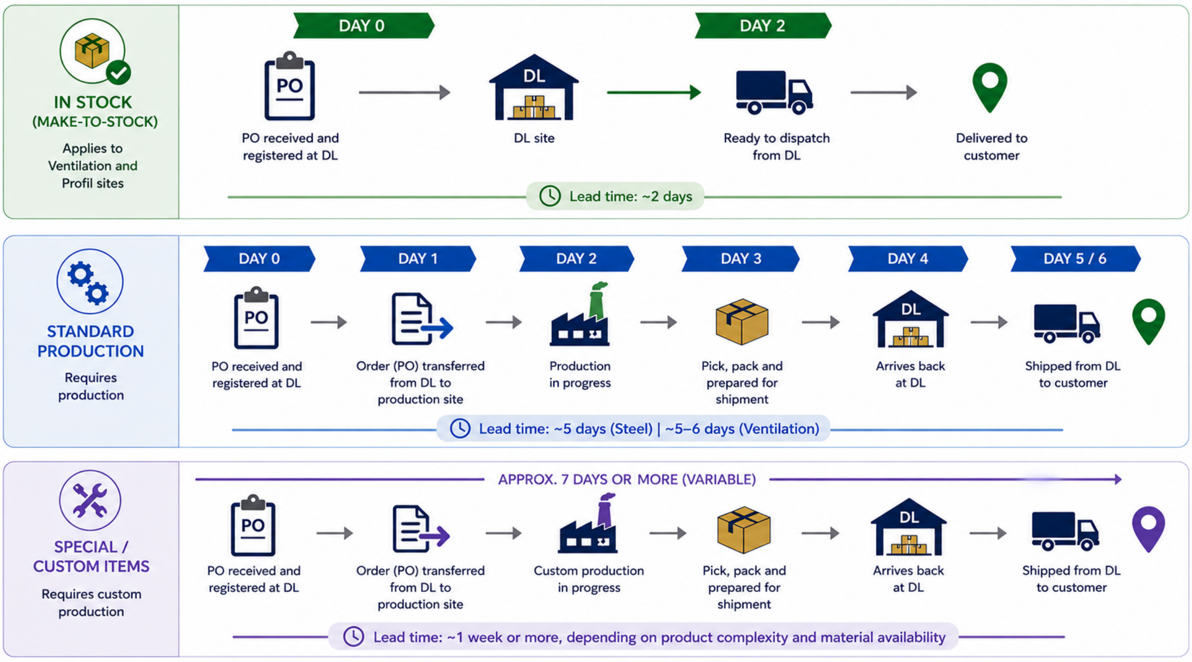


Figure 3: Order Flow by Item Type and Lead Time at Lindab

These variations in lead times, summarized in Figure 3, play a critical role in shaping the operational environment. In particular, they directly affect the identification of consolidation opportunities and must be carefully considered when designing and evaluating the CT concept.

To understand how these operations are managed, Lindab conceptualises its processes using a process management triangle consisting of Data, People, and System as shown in Figure 4. The Data corner represents process inputs, key performance indicators, and results that guide decision-making. The People corner emphasises the organisation and coordination of personnel to ensure processes are executed correctly. The System corner focuses on how CT's technology is structured and implemented, whether internally, externally, or as a hybrid solution. Within Lindab, the System must enable coordination across decentralised plants in different countries, supporting visibility, improved decision-making, and higher truck fill rates. This triangular framework helps visualise the interaction between data, people, and technology, emphasising that alignment among these three elements is essential for efficient and responsive operations.

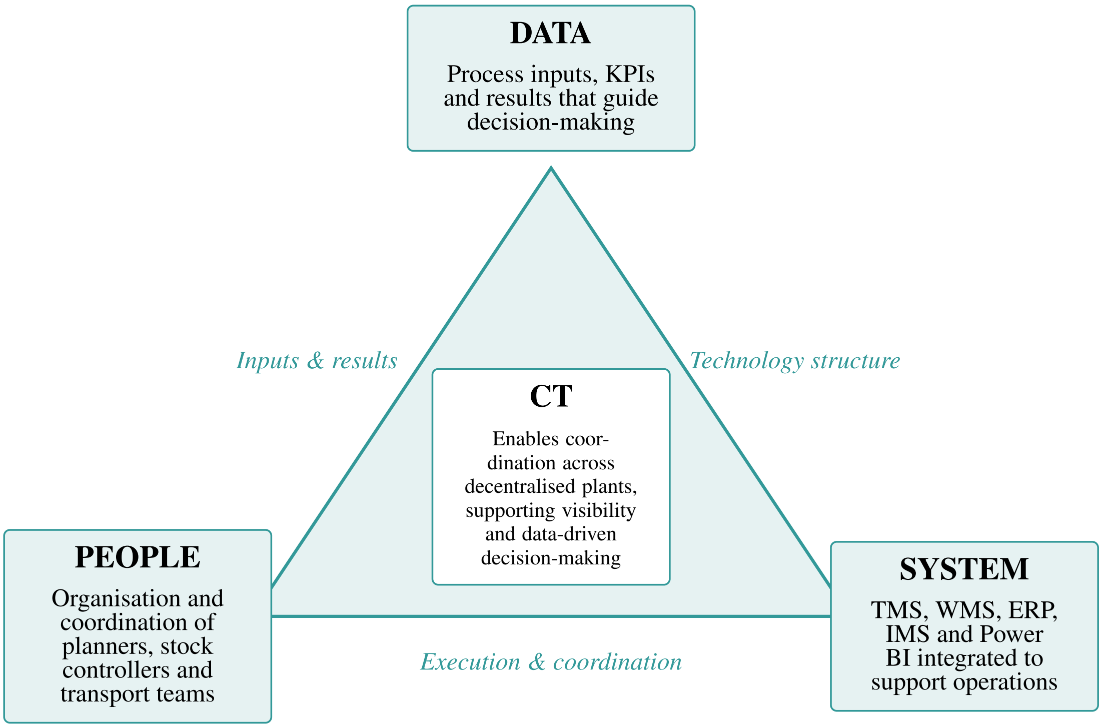


Figure 4: Management Triangle: Data, People and System at Lindab

1.3 Problem Formulation

Lindab operates a decentralized supply chain across multiple production and logistics sites in Europe, where transport planning and operational decisions are managed locally. The most critical consequence of this structure is a potential improvement of truck fill rate. Shipments are sometimes dispatched with unused capacity, particularly for bulky products, resulting in trucks transporting volumes of air.

This lack of coordination between plants and countries leads to duplicated transport efforts. In some cases, different countries send partially loaded trucks to the same destination, although shipments could potentially be consolidated into fewer vehicles with higher fill rate. As a result, more trucks than necessary are circulating on the roads, increasing transportation costs and negatively affecting Lindab's efficiency.

In addition, limited cross-plant visibility of inventory and stock levels restricts the ability to coordinate shipments and balance resources at a network level. Decisions are optimized locally rather than globally, reinforcing inefficient transport patterns and preventing effective consolidation.

To address these challenges, Lindab aims to improve network-wide visibility and coordination in order to increase truck fill rates, reduce duplicated transport flows and enable more efficient use of resources. A

CT is considered a potential solution to support centralized oversight, stock monitoring and coordinated decision-making across the supply chain.

1.4 Purpose

The purpose of this thesis is to analyse Lindab's current supply chain, identifying operational inefficiencies with a particular focus on logistics and improvements in truck fill rates. In addition, it will evaluate how the CT system can be beneficial for the company and analyse the opportunities and challenges associated with its implementation. Finally, the thesis will conduct an assessment of the company's business case, addressing the aspects identified as current implementation challenges, together with a future implementation plan os the system.

1.5 Research questions

To address the objectives of this thesis, the following research questions (RQs) are formulated:

RQ1: What structural and operational inefficiencies characterize Lindab's current supply chain, particularly in relation to transport utilization, inventory visibility, and cross-plant coordination?
This question aims to identify and analyze key inefficiencies, such as low truck fill rates, duplicated transport flows and limited inventory visibility, which restrict network-wide optimization.

RQ2: How can a CT contribute to improving visibility, coordination, transport efficiency, and inventory management within Lindab's decentralized supply chain?
This question evaluates the potential role and benefits of a CT solution, based on both theoretical insights and the identified operational challenges.

RQ3: What is the business case for implementing a Control Tower at Lindab, and what organizational and technical conditions must be met for it to deliver value?
This question assesses whether the potential operational and strategic benefits identified in RQ1 and RQ2 justify further investment in a CT solution. Based on the analysis of current inefficiencies and the expected improvements in visibility, coordination, transport utilization, and decision-making capabilities, the study will evaluate whether implementing a CT represents a viable and valuable direction for Lindab's future supply chain development.

1.6 Delimitations

In order for this thesis to make a meaningful contribution to Lindab, specific scope delimitations were established.

This thesis focuses on Lindab's logistics operations and service performance rather than the full end-to-end supply chain. It primarily addresses transportation planning, distribution flows, route efficiency, last-mile delivery, and truck fill rates. Inventory visibility is fully considered, as it represents a fundamental component of a CT and a prerequisite for improving coordination and transport consolidation across plants.

However, advanced inventory optimization models, such as safety stock optimization, reorder point calculations, or multi-echelon inventory design, are not developed within the scope of this thesis. These functionalities are considered potential future extensions of the CT solution. The initial implementation phase is expected to prioritize basic visibility and coordination capabilities, while more advanced optimization features may be introduced progressively as the system matures.

The study adopts a single case study approach to enable in-depth analysis. Advanced technologies such as AI, IoT, and data analytics are discussed at a conceptual level only. Confidentiality constraints limit the use of precise company data, resulting in a generalized representation of findings rather than full disclosure of internal figures. Despite these delimitations, the thesis aims to provide actionable insights for improving logistics efficiency, service performance, and network-level decision-making at Lindab.

1.7 Relevance

This thesis is relevant both from a practical and an academic perspective. From a company standpoint, it addresses the challenge of coordinating a highly decentralized supply chain, where limited cross-plant visibility and low transport utilization create measurable inefficiencies. By analyzing Lindab's logistics network and the viability of the CT implementation within the company, the study provides structured guidance for improving transport coordination and increasing truck fill rates.

From an academic perspective, existing literature on CTs primarily focuses on end-to-end visibility in global supply chains or on third-party logistics providers, while less attention has been given to internal coordination within decentralized industrial groups. Moreover, limited research explores how CTs can be implemented progressively in organizations where local autonomy strongly influences decision-making. Lindab represents a particularly suitable case, as its decentralized structure and ongoing digitalization efforts provide a real-world context to examine how a CT can support network-level optimization without removing local operational responsibility.

1.8 Target Group

The primary target group for this thesis is Lindab, particularly Supply Chain and Logistics Managers responsible for the coordination and transport performance. The viability analysis with requirements and future steps to implement the CT is intended to support decision-making at a strategic level, where visibility, cross-plant coordination and transport utilization are addressed.

Beyond Lindab, manufacturing and distribution companies with decentralized structures may find the results valuable, particularly those seeking to enhance supply chain visibility, improve coordination and optimize transport efficiency. The thesis also provides insights for researchers, offering an empirical case on the progressive implementation of a CT.

1.9 Non-disclosure Agreement

Throughout this report, all information and materials obtained from Lindab have been treated as confidential, in accordance with the signed non-disclosure agreement. As a result, specific operational data, financial figures and detailed performance metrics have been anonymized, aggregated or generalized to protect proprietary information.

This confidentiality constraint has influenced the research design. Quantitative findings are presented at an aggregated level rather than disclosing site-specific or country-specific performance data. In some cases, ranges or relative comparisons are used instead of exact figures. Additionally, certain internal system structures and decision-making processes are described conceptually rather than in full technical detail.

While these limitations reduce the level of granularity that can be publicly disclosed, they do not affect the analytical logic or the validity of the conclusions. The study focuses on structural patterns, coordination challenges and implementation principles, which remain representative despite data aggregation.

1.10 Report Structure

The structure of the thesis is outlined in Table 1, which provides an overview of the report together with a brief description of the content of each chapter.

Table 1: Structure of the Report

Chapter	**Content**
Introduction	This chapter introduces the thesis by providing background, a brief company overview, the problem statement, objectives, research questions, and the report's scope and structure.
Methodology	This chapter describes the research approach adopted in the thesis, outlining the case study design, data sources, and analytical framework used to examine Lindab's SC and the applicability of a CT.
Literature Review	This chapter presents the theoretical findings on CTs, including the definition, benefits, barriers, critical success factors, conceptual framework for implementation, architecture and requirements.
Empirical Data	This chapter presents the data collected mainly through interviews and includes quantitative analysis of transport inefficiencies to assess the potential impact of implementing the CT. It also highlights the company's logistics, pilot project, challenges, and implementation needs.
Results and Analysis	This chapter builds on the literature review and empirical data to define the requirements for a CT at Lindab. It presents an study of the opportunities and challenges with the implementation, a conceptual model for Sweden, identifies needed master data and assesses feasibility using SWOT, Business Model Canvas, and a tailored MAPE-K and change management roadmap framework.
Discussion	This chapter reflects critically on the study's scope and limitations, discussing the generalization of the results, the complexity of Lindab's supply chain as a case study context, and the methodological choices made throughout the research. It also outlines the study's academic contribution and directions for future research.
Conclusion	This chapter answers the research questions defined at the outset of the thesis, summarizes the key findings, and provides concrete recommendations for Lindab regarding the implementation and future development of the CT.

2 Methodology

This chapter outlines the methodological approach adopted in this study. It first explains the reasoning behind the chosen research purpose and approach and then describes the research design. Following the data collection and analysis. Lastly, the quality of the research is examined through a discussion of validity and reliability.

2.1 Research Methodology Framework

The objective of research is to produce valid and relevant knowledge grounded in empirical data and logical reasoning. To achieve this, research findings must be presented clearly to the academic community so that valid conclusions can be drawn and meaningful contributions can be made to the field of study (Paul Johannesson, 2021). Research methodology is essential for achieving success in academic writing, as it provides a systematic framework for structuring and analyzing the research process from its inception to the dissemination of results (Adeoye, 2024). One widely used framework to support this process is the research onion proposed by Saunders et al. (2006b), shown in Figure 6, which conceptualizes research methodology as a series of interconnected layers, ranging from the purpose of the research to specific methods and techniques.

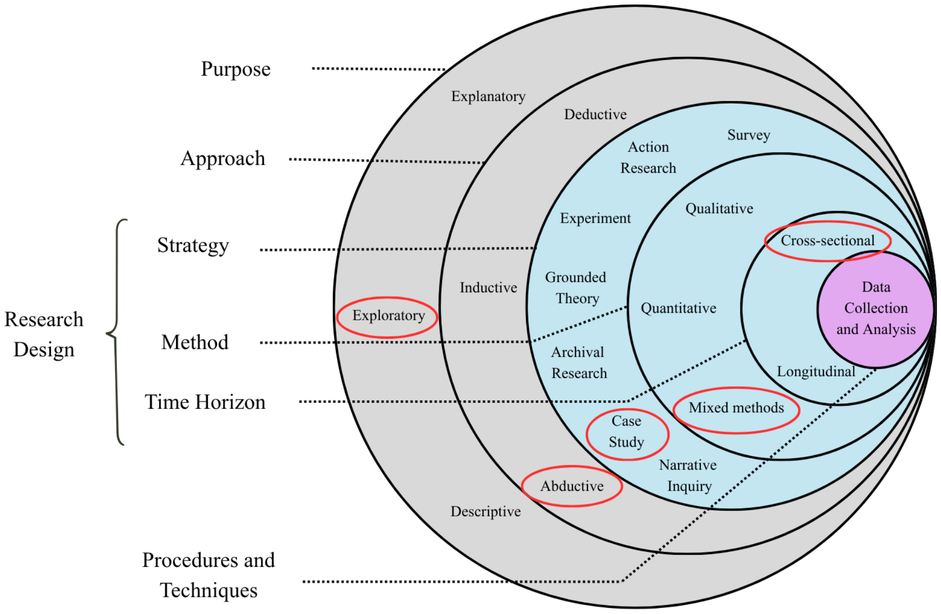


Figure 5: Modified version of the Research Onion developed by Saunders et al. (2006b)

2.2 Research Purpose and Approach

The first layer focuses on the research purpose, which can generally be classified into three main types: exploratory, descriptive, and explanatory (Sakyi et al., 2020). As the aim of this thesis is to explore the benefits and feasibility of implementing a CT in Lindab, the exploratory purpose is the most applicable in this case. Exploratory research is particularly valuable when a researcher enters a new area in which little is known and where the existing literature is limited or fragmented (Sakyi et al., 2020). According to Li, Miskon, Mohd Jamal, et al. (2024), although researchers from various industries have addressed topics related to CTs, the body of academic research remains relatively scarce and lacks investigation. Consequently, the purpose of exploratory research in this context is to develop a deeper understanding of the phenomenon and to generate new insights that are relevant to Lindab (Pandey & Pandey, 2015; Swaraj, 2019).

Once the research purpose has been defined, the research approach must be established in accordance with the research onion framework. Three main research approaches can be distinguished: deductive, inductive, and abductive (Malhotra, 2017). The present study adopts an abductive research approach, since in this thesis it is combined elements of both deduction and induction by moving iteratively back and forth between data and theory making comparisons and interpretations. This thesis starts with the observation of a phenomenon, in this case the observation of inefficiencies in transport, then there's a data collection, both theoretical and empirical to be able to identify patterns and then there's a iterative cycle testing theory and data to come to a conclusion.

2.3 Research Design

The next layer of the research onion concerns the research strategy. A research strategy represents the overall plan for conducting a research study and provides guidance for planning, executing, and monitoring the research process (Paul Johannesson, 2021). Several research strategies can be applied, including experiments, surveys, case studies, and simulations (Paul Johannesson, 2021). In this thesis, a case study strategy is the most appropriate, as it examines a single instance of a contemporary phenomenon, namely CTs, allowing for an in-depth understanding of the phenomenon within its real-life context, represented by Lindab's current supply chain. Additionally, case studies usually use a rich variety of data sources (Eisenhardt & Graebner, 2007), as in this thesis, interviews, data, and archival data is used. Furthermore, unlike other strategies such as action research, this approach does not involve the direct implementation of an artifact. Instead, it focuses on the analysis of empirical data, which, depending on the nature of the study, may be quantitative or qualitative ; however, in a case study research, the primary emphasis is on qualitative data (Dresch, Pacheco Lacerda, & Cauchick Miguel, 2015).

While the research strategy supports the overall direction of the study, it needs to be complemented with research methods that guide the collection and analysis of data in a more detailed manner (Paul Johannesson, 2021). Research methods can be quantitative, qualitative, or mixed, depending on the nature of the research and the type of data collected (Adeoye, 2024). Qualitative research is typically conducted through interviews or observations in order to gain an understanding of underlying reasons, motivations, and subjective experiences related to the research phenomenon (Adeoye, 2024). Quantitative research, in contrast, focuses on the collection and analysis of numerical data to test hypotheses, identify patterns, and establish causal relationships (Adeoye, 2024). The combination of these two methods is referred to as the mixed methods approach (Paul Johannesson, 2021). The mixed methods approach is considered the most appropriate for this thesis because it provides a more comprehensive understanding of the research problem. By offering flexibility to explore the research questions from multiple perspectives, it allows for a broader range of evidence to support and inform the conclusions drawn (Adeoye, 2024).

And finally, from a time-horizon perspective, cross-sectional studies examine a phenomenon at a single point in time, providing a snapshot of the situation, while longitudinal studies collect data over an extended period to evaluate change and development (Saunders et al., 2006a). As this thesis is conducted within a limited time frame, 5 months, a cross-sectional design is adopted.

2.4 Data Collection

And the final layer of the research onion adopted to explain the methodology concerns data collection techniques. This study begins with a literature review in order to gain a comprehensive understanding of the current state of knowledge in the field and to identify gaps that support further development of the research (Adeoye, 2024). Furthermore, as explained in the previous section, a mixed methods approach has been adopted. Consequently, both quantitative and qualitative data are combined in this study. Given the exploratory nature of the research, the data collection sequence follows the approach proposed by Terrell (2012), which is presented in Figure 6:

Figure 6: Sequential exploratory strategy in a mixed-methods research design by Terrell (2012)

The methodology for collecting each type of data used in this thesis is explained in the following sections.

2.4.1 Literature Review

A review of relevant literature provides a solid foundation for academic research by supporting theory development, consolidating existing knowledge, and identifying gaps that require further investigation (Webster & Watson, 2002). The studied subject area in this thesis is the implementation of CTs in supply chains and the associated benefits for supply chain visibility, coordination, and performance, which guided the selection of search terms used to identify relevant literature. The methodological literature review of this thesis followed a structured four-step approach, adapted from Okoli and Schabram (2010), to ensure a rigorous and transparent review process.

1. *Planning:* The purpose of the review was defined and the review protocol was drafted, familiarizing ourselves with the criteria and procedures for selecting and evaluating studies.

2. *Selection:* Relevant literature was identified through systematic searches in academic databases (Scopus, Web of Science, Google Scholar, Research Gate) and practical screening of titles, abstracts and full texts using keywords such as “Supply Chain CT”, “Logistics Visibility”, “Logistics CT” and “Supply Chain Performance”.

3. *Extraction:* Key information was extracted from each study, including research design (e.g. case study, survey, mixed-methods), data sources (interviews, operational data, documents), data collection procedures and quality assessment of each study.

4. *Execution:* The extracted data were synthesized and organized into thematic categories. Patterns, common methods and gaps were identified, providing guidance for the research methods adopted in this thesis. The review was then written up clearly to ensure transparency and reproducibility.

In the following Figure 7 is represented the systematic research method followed:

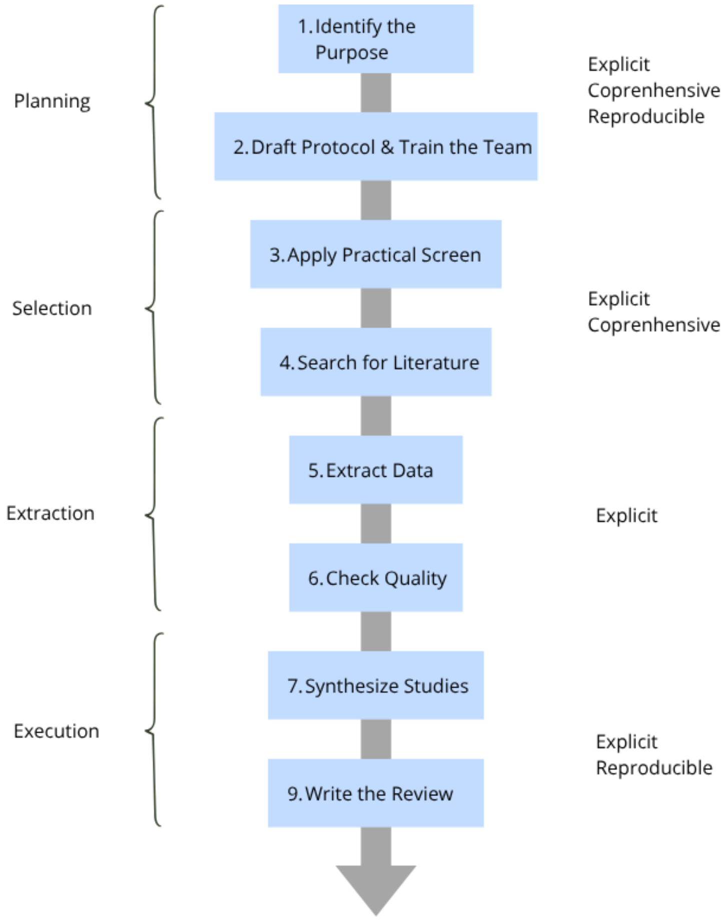


Figure 7: Modified version of the Systematic Guide to Literature Review Development by Okoli and Schabram (2010)

This process was conducted iteratively, between phase 2 and 3, as the review of the selected studies led to the identification of additional relevant articles referenced within the literature. This iterative approach helped ensure a more comprehensive understanding of the existing knowledge of the topic studied and improved the robustness of the literature review. In total, 32 articles were included and analysed in the literature review of this thesis.

2.4.2 Qualitative Data

Qualitative data consist of “words” collected through interviews, focus groups, participant observation, and related methods (Yauch & Steudel, 2003). Given the nature of case study research, qualitative data typically constitute the predominant source of evidence (Dresch, Lacerda, & Cauchick Miguel, 2015). In qualitative studies, interviewing is one of the primary techniques used to collect data, aiming to generate themes, theories, and models (Cassell, 2005; Paradis et al., 2016). Furthermore, Alsaawi (2014) identifies four main types of interviews: structured, unstructured, semi-structured, and focus groups. The type selected for this thesis is semi-structured interviews, in which questions are prepared in advance; however, the interviewer allows participants to elaborate on specific topics through the use of open-ended questions (Alsaawi, 2014).

Qualitative data were collected through interviews with Lindab employees to gain insights into the company’s current supply chain situation and the implementation of the CT. Key individuals within the organization were selected based on their relevance to the research topic following a theoretical logic, an iterative logic that aligns well with the abductive approach. The sample wasn’t define from the beginning, instead, it was collected some data, then analysed and then used the emerging theory to choose the next sample (Paul Johannesson, 2021) . Additionally, interviews were conducted with representatives from external companies to gather insights into how other organizations approach the implementation of digital platforms in their supply chains and to identify the main parameters they consider in the process. Some interviews were conducted online via Microsoft Teams, while others took place in person in Grevie. Each interview lasted approximately one hour and the questions were prepared before hand, the company, date and main insights taken from each interview is shown in Table 2.

Table 2: List of performed Interviews

Interviewee	**Company**	**Date**	**Purpose / Main Insights**
Interviewee A	External Company	2026-02-13	Former CEO of a successful company offering CT services. Overview of the topic throughout the years and the current state of the industry.
Interviewee B	External Company	2026-02-13	Company currently attempting to implement a CT. Understanding the motivations, current status, and challenges identified during implementation.

Interviewee	Company	Date	Purpose / Main Insights
Interviewee C	External Company	2025-02-17	Successful company implementing a CT, with extensive knowledge about pre-implementation requirements.
Interviewee D	Lindab	2026-02-18	Broad knowledge about the current CT pilot and understanding of the current process.
Interviewee E	Lindab	2026-02-18	Insights into the motivations for implementing the CT and the main limitations of the current supply chain.
Interviewee F	Lindab	2026-02-24	Extensive knowledge about inventory management.
Interviewee G	Lindab	2026-02-24	Broad knowledge about the supply network and the company's purchasing strategy.
Interviewee H	Lindab	2026-02-24	Currently developing a 3D model to improve truck fill rates and support the CT PoC. Knowledge about data and the potential of the tool.
Interviewee I	Lindab	2026-02-25	Extensive knowledge about internal logistics (picking, packing, warehouse management) and the systems used.
Interviewee J	Lindab	2026-02-25	Insights into Central Region logistics and the CT implementation approach in the area.
Interviewee K	Lindab	2026-02-25	Insights into Region North logistics and the CT implementation approach in the area.
Interviewee L	Lindab	2026-02-25	Extensive knowledge about steel supply and logistics in Region West.
Interviewee M	Lindab	2026-03-05	Insights into transport optimization, planning horizon extension, and balancing cost efficiency with service performance.
Interviewee N	Lindab	2026-03-05	Strategic perspective on logistics, focusing on cost reduction, inventory optimization, and managing increasing complexity.
Interviewee O	Lindab	2026-03-25	Insights into administrative and operational logistics processes in Lindab Norway, focusing on coordination and supply chain execution.
Interviewee P	Lindab	2026-03-26	Operational perspective on distribution center management, internal logistics flows, and warehouse performance.

Interviewee	Company	Date	Purpose / Main Insights
Interviewee Q	Lindab	2026-03-27	Strategic business development perspective on supply chain challenges and improvement opportunities within Lindab.
Interviewee R	Lindab	2026-04-23	Insights into production planning, data quality, forecasting challenges, and the potential role of a CT in improving coordination and operational efficiency.

To ensure that the interviews were conducted in a rigorous and trustworthy manner, several measures were implemented. First, participant consent had to be obtained, and confidentiality regarding the information provided had to be ensured (Denscombe, 2010).In addition, the interviewer had to avoid adopting a subjective position that could influence the participants (Sreejesh et al., 2014). Furthermore, a rigorous record of the interviews was maintained through audio transcriptions and notes taken during the interviews (Paul Johannesson, 2021). Finally, written transcriptions were produced without distorting the words of the interviewees.

2.4.3 Quantitative Data

Quantitative research is characterized by the systematic collection and analysis of numerical data with the aim of testing hypotheses, identifying patterns, and examining potential causal relationships. It relies on statistical tools and techniques to measure variables, assess outcomes, and generate findings that can be generalized to a broader population (Adeoye, 2024). In this approach, numbers constitute the primary unit of analysis (Denscombe, 2010), as data are gathered through structured methods such as surveys and other measurement instruments, producing quantifiable results that can be statistically analyzed (Yauch & Steudel, 2003). According to Gaciu (2021) there are two types of quantitative data. If data is acquired directly by the researcher, then it is classified as primary quantitative data. If quantitative data is collected from other people, it is classified as secondary quantitative data.

In the case of the current study, most of the qualitative data used are of a secondary nature, as they are provided by Lindab. These data are primarily numerical, coming from the proof of concept (PoC) conducted within the company using tools such as Power BI, ERP, and TMS. Additionally, data from the company itself associated with the most recent year, 2025, are also used, as this represents the most relevant information.

2.5 Data Analysis

Qualitative data must be sorted and categorized in a systematic manner so that raw data (i.e., interview transcripts) can be transformed into meaningful findings (Williamson & Johanson, 2018). The data analysis procedure adopted in this thesis follows the grounded theory approach proposed by Denscombe (2010). This method is particularly associated with the analysis of interview transcripts, aiming to generate concepts and theoretical insights that reflect the meanings contained within the data. This theory follows the following steps:

1. *Explore the data*: The first step in grounded theory analysis involves becoming familiar with the data through repeated readings of the transcripts, cross-referencing them with field notes in order to get a first understanding and begin identifying emerging themes.

2. *Memos*: During the analysis process, researchers have to record insights and interpretations in memos, which serve as a structured way to document analytic reflections, refine codes and categories, and provide a transparent record of decision-making.

3. *Code the data*: In this step, the researcher has to attach labels to units of raw data in order to link segments of the material to relevant analytical ideas. The researcher must first determine the unit of analysis (e.g., words, sentences, or paragraphs), then decide what aspects will be coded and finally establish initial codes, which may emerge from the data itself or from preliminary analytical assumptions. These codes will be continuously refined throughout the research process.

4. *Categorize the data*: Lastly, codes are grouped into broader categories that function as umbrella terms for related concepts. As analysis progresses, overlapping codes and categories are organized into hierarchical structures, distinguishing between higher-level and lower-level codes. This iterative process requires continuously revisiting the data, refining categories and developing key concepts in the data.

2.6 Research Quality

Ensuring research quality is a key aspect of this study. The evaluation focuses on validity, reliability and the triangulation of multiple data sources and methods. The methodological choices and data collection procedures are designed to provide robust, credible and actionable findings (Miles et al., 2014; Snyder, 2019).

2.6.1 Validity

Validity is an essential concept in research methodology, ensuring the integrity and trustworthiness of findings (Adeoye, 2024). In this thesis, validity is achieved through several mechanisms. First, content validity was addressed by ensuring that the software tools and measurement methods used adequately captured the operational performance indicators and logistics inefficiencies analysed in the study. The calculations generated by the systems were verified to ensure that they accurately represented the company's operations. Furthermore, construct validity was also considered in order to evaluate whether the measurements performed corresponded to the theoretical concepts being analysed. In this thesis, convergent validity was applied, as all the measurements were oriented towards the same underlying concept (Sreejesh et al., 2014). In addition, external validity was addressed to evaluate the extent to which the conclusions derived from the data could be generalised to broader populations, in this case to other companies. This validation was carried out through interviews with external companies in order to assess how replicable the Lindab environment and the current project context are.

On the other hand, the validity of the qualitative data is associated with the concept of credibility, since it cannot be demonstrated in the same way as in a quantitative experiment (Denscombe, 2010). This validity was assessed through respondent validation, consisting of double-checking the interview transcriptions with the participants whenever there were ambiguities or potential misunderstandings. In addition, the analysis of the qualitative data was conducted following an objective approach, without excluding findings that did not align with the expected analysis (Denscombe, 2010).

Data triangulation was also carried out with the aim of analysing the collected data from different perspectives in order to obtain a deeper understanding of the conclusions reached (Denscombe, 2010). In this case study, methodological triangulation was used, which is the most common form of triangulation adopted by social researchers (Denscombe, 2010). This type of triangulation was conducted between quantitative and qualitative methods in order to contrast results while complementing and enriching the findings with additional insights. In this thesis, triangulation was achieved through the combination of interview findings and logistics inefficiency data, as both sources complemented each other.

2.6.2 Reliability

Reliability refers to the consistency and replicability of the research process and findings (Miles et al., 2014), and it is addressed according to the type of data used.

For quantitative data, different tests were carried out, such as test-retest reliability, which consists of applying the same calculations to two datasets in order to verify whether the results remain consistent and reliable (Denscombe, 2010; Sreejesh et al., 2014).

On the other hand, for qualitative data, reliability is reformulated as dependability, since it is highly unlikely that another researcher could fully replicate the study when this type of data is involved (Denscombe, 2010). Therefore, an audit trail was maintained, documenting all methodological decisions so that other researchers could inspect the process and evaluate whether the decisions were made in a reasonable and transparent manner (Denscombe, 2010), as is currently being done through the explanation of the methodology. By clearly documenting each step of data collection and analysis, other researchers can replicate or follow the process, ensuring that the results are transparent and trustworthy.

In addition, inter-observer consistency was also considered, which is particularly relevant in this case study. This concept refers to the extent to which two researchers observing the same event record the same data. This was ensured throughout the thesis as the research was conducted collaboratively by two authors.

Finally, it is important to consider the relationship between reliability and validity. An instrument that lacks consistency and produces different results without changes in the measured variables will also lack validity. However, a highly reliable instrument may still not be valid if it does not measure the intended concept correctly. In such cases, the instrument may consistently produce inaccurate results. Therefore, reliability is a necessary, but not sufficient, condition for ensuring the quality and success of a research study (Sreejesh et al., 2014).

3 Literature Review

This section compiles and analyzes previous research related to the thesis topic in order to lay the foundation for the study. It includes a review of the relevant literature and the main theories proposed by different authors; in this way, we stablish the theoretical framework and contextual background necessary to answer the research questions.

3.1 Introduction

The concept of CT is gaining increasing importance as essential components of modern SCM (Chaffin et al., 2024). Its implementation is becoming necessary to maintain competitiveness and organizational resilience, particularly in a context where supply chains face challenges such as demand volatility (Chaffin et al., 2024; Nadar et al., 2025). In this scenario, CT enables improved real-time coordination, support decision-making processes, and strengthen the ability of organizations to respond to disruptions (Nadar et al., 2025).

Despite their growing practical relevance, academic research on CTs remains limited and fragmented, as they are a relatively new concept (Chaffin et al., 2024). Nevertheless, in recent years the term has gained greater recognition for its ability to integrate information technology systems and optimization tools within the supply chain context (Harmelink, Topan, & van Hillegersberg, 2025). Interest in CTs has increased significantly since 2020 in the academic literature, and the topic is expected to continue growing in the coming years (Li, Miskon, Jamal, et al., 2024).

3.2 Defining CTs

The term "Control Tower" originates in the aviation sector, where it refers to a structure located at airports from which the takeoff, landing, and movement of aircraft are monitored and coordinated (Gunasekaran et al., 2021). This concept was subsequently adopted in the field of supply chains as a response to the increasing complexity driven by globalization (G. Bhosle et al., 2011). Therefore, the term Supply Chain CT (SCCT) emerged at the beginning of the 21st century, conceived as a mechanism designed to enhance coordination, visibility, and decision-making across the supply chain (Li, Miskon, Mohd Jamal, et al., 2024).

The concept of CT is relatively new and presents a certain degree of fragmentation through literature (Li, Miskon, Mohd Jamal, et al., 2024). Various definitions have been identified, derived from academic articles and white papers. So, Table 3 shown below compiles the most relevant definitions with the aim of identifying common elements and conceptual divergences that contribute to understand the concept.

Table 3: Definitions of CT in the Literature

Reference	Definition
Alias et al. (2014)	“decision-support systems merging different data streams from various subordinate levels and displaying the consolidated information at a higher level for the purpose of monitoring and control of processes while pursuing the goal of optimal process operation”
Bleda et al. (2014)	“centralized hub that uses real-time data from a company’s existing, integrated data management and transactional systems to integrate processes and tools across the end-to-end supply service chain and drives business outcomes”
Capgemini (2011)	“data collection system using technology, processes and enterprises in a supply chain that allows companies to understand better, prioritize, and solve critical problems in real-time”
Chaffin et al. (2024)	“centralized platforms that provide end-to-end visibility and control over the entire supply chain”
Gartner (2022)	“central hub with the technology, processes, and organization to capture and use supply chain data in real time, providing enhanced visibility for improved decision-making”
G. Bhosle et al. (2011)	“central hub with the required technology, organization and processes to capture and use supply chain data to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives”
Harmelink (2022)	“An (inter-) organizational system which uses IT to optimize specifically (a port of) the service logistics supply chain”
Li, Miskon, Mohd Jamal, et al. (2024)	“decision support systems integrating data from various levels, monitoring and controlling processes in real-time, and achieving optimal operations”
Milenković et al. (2019)	“information sharing platform that will support planners in supply chain optimization and fulfill the shipper’s requirements for real-time visibility in whole transport chain”
R. Verma et al. (2020)	“platform for execution control of the supply chain processes in logistics system by reviewing the processes, visualizing status, registering deviations and providing useful insights through optimization methods for robust decision-making”
Siena et al. (2021)	“inter-connected and personalized dashboard of data, business metrics and events to support the logistic flows and the decision-making process”
Trzuskawska-Grzesińska (2017)	“planning and execution system, that effectively deals with resource constraint and/or contention as well as process deviation in order to execute corrective and preventive actions in real-time. Its purpose is to regulate the supply chain by maximizing service, minimizing cycle time, while optimizing resources”

The definitions provided above share several overlapping features but also highlight some distinct characteristics. The first distinction is that some authors describe CT as a central hub (G. Bhosle et al., 2011; Bleda et al., 2014; Chaffin et al., 2024), while others conceptualize it as an information-sharing platform (Milenković et al., 2019) or as a decision-support system (Alias et al., 2014; Li, Miskon, Mohd Jamal, et al., 2024). The concept of an "information-sharing platform" suggests that any system that simply shares information could be considered a CT, and therefore does not adequately reflect the complexity or level of integration required in a CT. In contrast, the definition of a "central hub" refers to a system that unifies data from multiple levels, providing consolidated visibility across the supply chain. Finally, a "decision-support system" implies that the system cannot operate independently, which may not apply to certain functions of a CT. For these reasons, this study adopts the central hub definition, with the specific function of supporting decision-making.

Another aspect to consider is the emphasis on real-time data. Some authors highlight that CT should be capable of real-time tracking and visibility (Li, Miskon, Jamal, et al., 2024; Milenković et al., 2019; Trzuskawska-Grzesińska, 2017; R. Verma et al., 2020). In contrast, other authors do not mention real-time requirements, focusing instead on data integration and consolidation from multiple sources for monitoring and control (Alias et al., 2014; G. Bhosle et al., 2011; Bleda et al., 2014; Chaffin et al., 2024). This discrepancy raises questions about the practical necessity of real-time data in all CT applications, especially in contexts where data transmission may experience delays due to technological or operational constraints. In the case of Lindab, the real-time data is available so this concept is added to the definition.

Therefore, a CT can be understood as a *"central hub system that supports the supply chain by providing real-time visibility and tracking, enabling effective decision support throughout the operational and strategic processes."*

Continuing with the definition of this concept, it is relevant to explain the difference between a CT and a Digital Twin (DT), as both technologies emerged with Industry 4.0 and present partially overlapping characteristics (J. Patsavellas et al., 2021). While the CT is defined as a central hub that coordinates the supply chain, as previously discussed, the DT is defined as a computerized model that represents a real-world process in real time; in other words, it acts as a simulation engine (J. Patsavellas et al., 2021; Schenk & Clausen, 2020). Establishing a relationship between both concepts, DTs enable CTs to evolve from simple monitoring dashboards into intelligent, predictive, and prescriptive tools (Nadar et al., 2025). For example, in a CT for construction logistics, the digital twin is used to simulate forecasted building activities using, for instance, BIM data, and can predict future logistics activities required (Harmelink, Merrienboer, et al., 2025). Furthermore, regarding which technology should be developed first, achieving a DT tailored to the supply network is highly complex. Therefore, it is recommended to first implement the operational CT in order to establish the necessary data foundation and subsequently develop the complete DT for the entire supply chain (Schenk & Clausen, 2020).

3.3 CT Architecture: The MAPE-K Framework

As discussed in previous chapters, modern supply chains operate in an environment defined by volatility, uncertainty, complexity, and ambiguity (Dymyt et al., 2024; J. Patsavellas et al., 2022), where disruptions are increasingly difficult to anticipate and manual coordination alone is no longer sufficient (Dautov, 2016). This has pushed organizations toward systems capable of self-adaptation: infrastructures that can monitor their own state, detect anomalies, and respond without waiting for human intervention (Abdennadher et al., 2017).

The conceptual foundation for this behavior is Autonomic Computing, a paradigm introduced by Kephart and Chess, 2003 that draws an analogy between complex technical systems and the human autonomic nervous system, the mechanism that keeps us breathing and our heart beating without conscious thought (Dautov, 2016). Several architectural frameworks have since been proposed to translate this idea into practice, including domain-specific functional models such as those by Liotine (Liotine, 2019b) and Hofman (Hofman, 2014), as well as the five-layered information architecture introduced by Shou-Wen et al. (Shou-Wen et al., 2013). Despite this variety, the MAPE-K loop has emerged as the most widely adopted functional architecture for Supply Chain CTs (Alias et al., 2014; Harmelink, 2022). What sets it apart from alternative models is the central Knowledge component that connects all phases, enabling the system to learn from historical data and improve its decision-making over time, which is what separates a CT from a simple visibility dashboard.

The MAPE-K loop structures this capability into four phases: Monitor, Analyze, Plan, and Execute, all connected to a shared Knowledge base (Alias et al., 2014). Each phase plays a distinct role in enabling autonomous supply chain management, and understanding them individually is key to understanding how a CT functions in practice:

MONITORING (M)
Monitoring is the entry point of the MAPE-K loop and the foundation of a CT's operational awareness (Alias et al., 2014). Its role is to continuously collect, aggregate, and filter data from heterogeneous sources such as ERP, TMS, WMS, and IoT sensors to create a real-time picture of the environment (Alias, Özgür, et al., 2015). In CT terms, this phase provides end-to-end visibility, enabling the tracking of shipments, inventory levels, and asset statuses across the entire network (Siena et al., 2021). Dashboards and alert systems highlight irregularities (like a delayed shipment) but do not yet act on them, that responsibility falls to the next phase (Harmelink, 2022).

ANALYSIS (A)
Analysis is the intelligence engine of the MAPE-K loop, where raw data is transformed into actionable diagnosis (Dautov, 2016). Its primary role is to compare the real-time supply chain status captured during Monitoring against predefined target values, such as operational plans or Service Level Agreements (SLAs) (Alias et al., 2014). In CT terms, this phase acts as an exception management engine: it evaluates "symptoms" to determine if a deviation (such as a delayed shipment or a resource breakdown) constitutes a critical deviation that requires a response (Alias et al., 2014). If a significant mismatch is detected, Analysis generates a Change Request, which serves as the formal trigger for the Planning phase (Dautov, 2016). Within CT maturity models, this phase enables the system to move beyond simple visibility toward proactive risk diagnosis and automated alerting (Harmelink, 2022).

PLANNING (P)
Planning is the decision-making stage of the MAPE-K loop, where the system translates diagnostic intelligence into actionable strategies (R. Verma et al., 2020). Based on the Change Request generated during the Analysis phase, this component develops and proposes action alternatives or "Change Plans" designed to return the supply chain to its favored operational state (Alias, Özgür, et al., 2015; Alias et al., 2014). In CT terms, this phase functions as a Decision Support System (DSS) (Alias, Özgür, et al., 2015; Harmelink, 2022). It utilizes simulation and optimization methods to evaluate "what-if" scenarios (such as rerouting shipments, selecting alternative suppliers, or re-allocating inventory) to proactively resolve exceptions, for example, using DT (Alias, Özgür, et al., 2015; Alias et al., 2014). Within maturity frameworks, Planning provides intelligent guidance to users, paving the way for the autonomous control found in the highest levels of evolution (R. Verma et al., 2020).

EXECUTION (E)
Execution is the final functional stage of the MAPE-K loop, where selected strategies are converted into physical or logical actions within the supply chain (Alias et al., 2014; R. Verma et al., 2020). Its role is to provide the interface where action alternatives developed in the Plan phase are applied to the problem and then communicated to connected technical systems via actuators or effectors (Alias et al., 2014). In CT terms, this is the orchestration phase: the CT sends specific commands back to managed systems (such as an ERP to update a purchase order, a TMS to

reroute a shipment, or a WMS to trigger stock replenishment) to restore the desired operational state (Alias, Özgür, et al., 2015). Within maturity frameworks, Execution is the state where the system moves beyond simple visibility to perform autonomous or semi-autonomous interventions with minimal human micro-management (Harmelink, 2022).

Rather than being a sequential step, **KNOWLEDGE (K)** serves as the unifying central repository and the logical core shared by all functional phases of the loop (Dautov, 2016). It acts as the "brain" of the CT, administering and storing all data collected, processed, and retrieved throughout the cycle (Alias et al., 2014). By recording the operational reality captured during Monitoring and the specific outcomes of actions taken in Execution, the Knowledge base allows the system to identify patterns, tendencies, and causal relations over time (Alias, Özgür, et al., 2015; Alias et al., 2014). In CT terms, this centralized intelligence is what transforms the system into an intelligent orchestration engine, providing the predictive and prescriptive guidance necessary for the entire loop to learn from experience and optimize the supply chain autonomously (Alias et al., 2014).

Figure 20, adapted from Harmelink, 2022, illustrates the MAPE-K loop as applied to a CT, summarizing the interaction between the four phases described above. As shown, Monitor collects real-time signals from IoT devices and physical processes, Analyze evaluates them against rules and thresholds, Plan determines the appropriate response, and Execute issues commands back to the real-world process, all coordinated through the central Knowledge base.

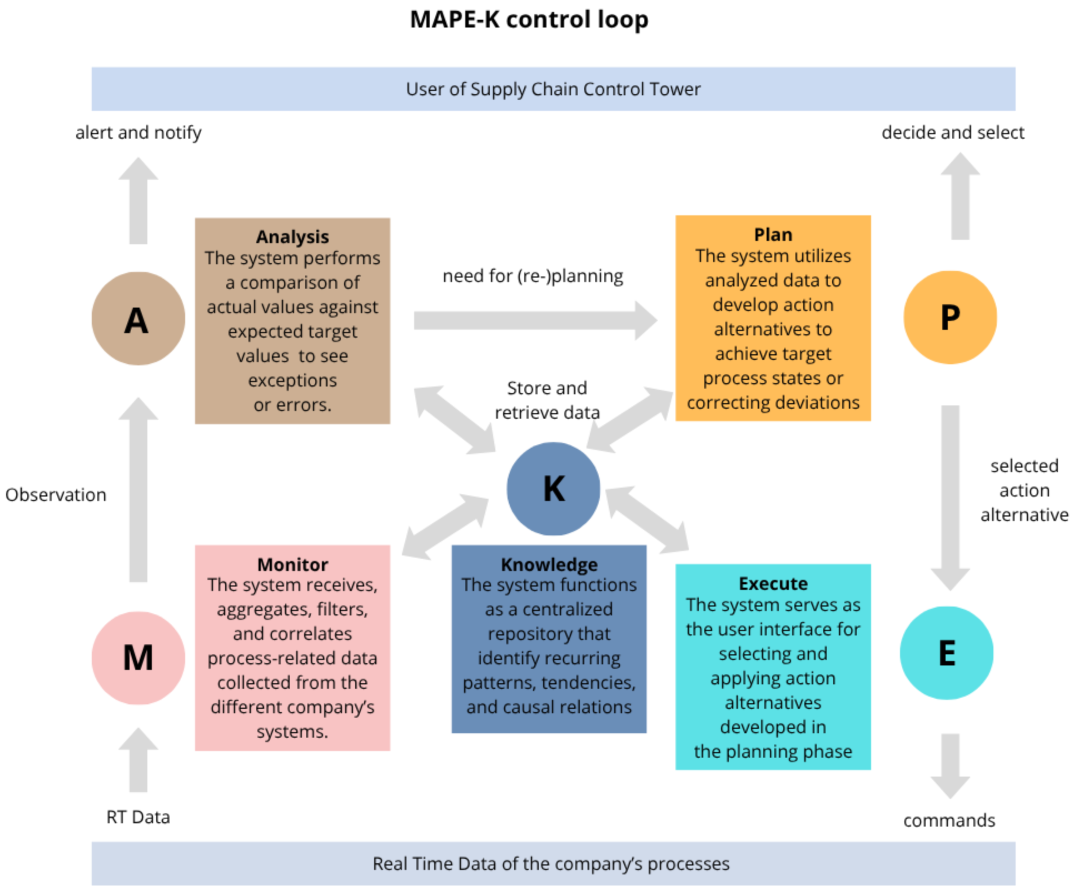


Figure 8: Modified MAPE-K loop applied to a Supply Chain CT by Harmelink (2022)

3.4 Implementation Framework

Implementing a CT requires the right data infrastructure to support decision-making at each stage and not only a structured rollout process (Brinch, 2018b). G. A. Smith (2022) proposes a three-phase framework that guides organizations from initial diagnosis through full operational optimization:

PHASE 1: STRATEGY DEVELOPMENT
G. A. Smith (2022) states that in phase 1 the main objective is to establish a clear starting point. Supply chain professionals are required to conduct a comprehensive review of the current (as-is) supply chain processes and assess the existing level of visibility. This involves identifying strengths and weaknesses, as well as evaluating the level of risk and determining appropriate mitigation or elimination strategies. According to the case of implementation described by Vlachos (2023), the organization had to rely heavily on the experience of its internal employees to understand how the supply chain was functioning, while simultaneously working on process optimization. This transition led to a temporary loss of visibility and certain resource constraints. However, strong support from top management enabled the team to overcome these challenges and move forward with the implementation.

PHASE 2: IMPLEMENTATION
Phase 2 is divided by G. A. Smith (2022) into two steps: Design and Implementation. During the Design stage, the processes and systems that will be used to achieve the expected supply chain visibility are specified and developed, including organizational design, process design, and system architecture. Regarding Implementation, the previously defined design is executed, staff are trained, and an experienced project manager is required to ensure proper execution. In the case analyzed by Vlachos (2021b), during this phase the company focused on integrating its internal systems with those of its suppliers, as these operate on multiple different platforms.

PHASE 3: RUN, EVALUATE & OPTIMIZE
In the final phase, G. A. Smith (2022) states that continuous adjustments are made to optimize and improve the system, as well as to enhance end-to-end visibility, ensuring that the CT operates at full capacity. Best practices can be assessed through benchmarking studies. In the case analyzed by Vlachos (2023), the company expanded into additional market areas and product segments, further extending the digitalization of its supply chain. To achieve this, it was necessary to standardize supply chain processes and strengthen the links between people and technology. A key success factor during this phase was the continuity of the team, which remained essentially the same from the very beginning.

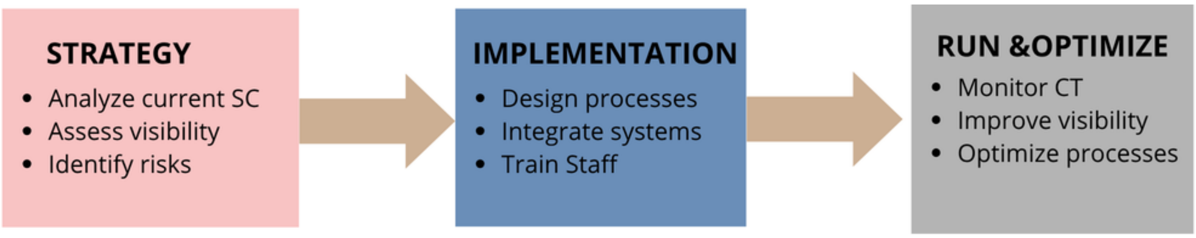


Figure 9: Framework of CT Implementation

3.5 CT Benefits

The implementation of a CT can generate a wide range of benefits across different segments of the supply chain. To systematically present these advantages, the benefits are categorized following the framework proposed by Capgemini (2011) into four areas:

- *General benefits:* These benefits span the entire supply chain, enhancing overall visibility, coordination, and decision-making. They support alignment between different business areas, enable centralized monitoring of processes, and contribute to more informed strategic and operational choices across the network.
- *Inbound benefits:* These relate to the management of materials and components from suppliers to production and distribution sites. They focus on improving the flow of incoming materials, optimizing planning at production units, and ensuring timely availability of inputs for manufacturing processes.
- *Manufacturing benefits:* These benefits concern production operations. They emphasize improved coordination of production scheduling, synchronization of outputs between sites, and efficient utilization of production resources to minimize delays and ensure continuity across the manufacturing network.
- *Outbound benefits:* These pertain to the distribution of finished products to customers or downstream distribution centers. They focus on optimizing transportation flows, increasing efficiency of delivery operations, and supporting effective service to customers through better coordination and management of distribution activities.

This categorization provides a structured framework for understanding how a CT can improve operational efficiency, coordination, and sustainability across a supply chain. The table below synthesizes these benefits and serves as a foundation for a detailed discussion and analysis based on academic and industry literature.

Table 4: Summary of CT benefits, organized into functional areas based on the classification proposed by Capgemini (2011)

Area of Benefits	List of Benefits
General	Integrated supply chain with real-time visibility, enabling enhanced decision-making and improved coordination (Alias et al., 2014; Capgemini, 2011; Chaffin et al., 2024; Din et al., 2026; Harmelink, Topan, & van Hillegersberg, 2025; Li, Miskon, Mohd Jamal, et al., 2024; Nadar et al., 2025; J. Patsavellas et al., 2021; Pereira et al., 2014; Trzuskawska-Grzesińska, 2017) Reducing costs, creating value and gaining competitive advantage (Alias et al., 2014; Chaffin et al., 2024; Din et al., 2026; Harmelink, Merrienboer, et al., 2025; Li, Miskon, Mohd Jamal, et al., 2024) Standardization and harmonization of processes, technology, and human resources, improving oversight and operational optimization (Chaffin et al., 2024; Din et al., 2026; Li, Miskon, Mohd Jamal, et al., 2024)

Continued on next page

Area of Benefits	List of Benefits
	Autonomous problem-solving and event-based alerts for disruptions (Din et al., 2026; Pereira et al., 2014; Siena et al., 2024) Enhanced transparency, single source of truth, and end-to-end visibility across the supply chain (Alias et al., 2014; Harmelink, Topan, & van Hillegersberg, 2025; J. Patsavellas et al., 2021) Integration of people, processes, and systems to improve supply chain performance (Chaffin et al., 2024; J. Patsavellas et al., 2021)
Inbound	Optimal inventory levels, reduced buffers, improved demand forecasting, and decreased packaging needs (Capgemini, 2011; Din et al., 2026) Synergies in procurement, transport carriers, and supplier collaboration to reduce total landed cost, transportation expenses, and inventory costs (Capgemini, 2011; Chaffin et al., 2024; J. Patsavellas et al., 2021) Offline and online planning, visibility on inventory and shipments, and improving planning (Harmelink, Merrienboer, et al., 2025; Siena et al., 2024) Enable collaboration with retailers to address demand surges or potential delays (Harmelink, Topan, & van Hillegersberg, 2025)
Manufacturing	Awareness of work in progress, improved productivity, and manufacturing optimization across global plants (Capgemini, 2011) Accurate demand planning, better scheduling, reduced cycle times, and lower inventory levels (Capgemini, 2011) Risk management, operational optimization, cost reduction, and efficiency gains (Chaffin et al., 2024; Din et al., 2026; Li, Miskon, Mohd Jamal, et al., 2024; J. Patsavellas et al., 2021)
Outbound	Improved load efficiency, transport optimization, and predictability of delivery (ETA) for customers (Capgemini, 2011; Chaffin et al., 2024; Li, Miskon, Mohd Jamal, et al., 2024; Pereira et al., 2014; Siena et al., 2024) Reduced carbon emissions, lower environmental footprint, and more efficient waste and transport management (Din et al., 2026; Li, Miskon, Mohd Jamal, et al., 2024) Cost reduction and optimization of supply chain operations through improved distribution and logistics performance (Chaffin et al., 2024; Harmelink, Topan, & van Hillegersberg, 2025)

Continued on next page

Area of Benefits	List of Benefits
	Continuity of retail operations and maximized customer service (Alias et al., 2014; J. Patsavellas et al., 2021)

The benefits presented in the table are well-documented across the literature, but their realization is neither automatic nor uniform. The most consistently supported finding is the link between CT implementation and improved end-to-end visibility: virtually every reviewed source identifies this as the foundational benefit from which others derive (Capgemini, 2011; Chaffin et al., 2024; J. Patsavellas et al., 2021). Without visibility, the remaining benefits: optimized transport, better inventory management, proactive disruption handling, cannot be systematically achieved.

What the literature makes less explicit is that these benefits are interdependent and sequential. Outbound gains such as load efficiency and emissions reduction depend on inbound and manufacturing coordination being in place first (Din et al., 2026; Li, Miskon, Mohd Jamal, et al., 2024). Organizations that implement a CT primarily as a monitoring tool (without integrating it into planning and decision-making processes) tend to capture only a fraction of the potential value (Alias et al., 2014; Nadar et al., 2025). This distinction between visibility as an end in itself versus visibility as an enabler of action is critical, and often underestimated in practice.

Finally, the strategic and sustainability benefits, while increasingly cited, remain the least empirically validated (Din et al., 2026; Harmelink, Merrienboer, et al., 2025). Cost reduction and competitive advantage are frequently mentioned as outcomes, but the conditions under which they materialize (organizational readiness, data quality, change management) receive comparatively little attention in the reviewed literature. This gap between reported potential and documented evidence is relevant context for any organization evaluating CT adoption.

3.6 CT Barriers

Despite the numerous benefits that CTs are expected to provide to organizations, their implementation remains limited (Siena et al., 2021). Freichel et al. (2022) propose a framework that categorizes the main barriers identified in recent literature into three groups (Figure 10). These challenges are generally presented at a broad level; therefore, a company's specific capabilities, resources, and organizational context must be evaluated in order to determine the particular barriers that may affect the adoption of a CT solution.

Figure 10: Modified version of barriers to CTs adoption by Freichel et al. (2022)

At the technology and people level, manual processes remain widespread, leading to information loss and delayed or incorrect data (Liotine, 2019b; Schenk & Clausen, 2020). CTs require a robust infrastructure to function, and the change this demands is frequently hindered by employee resistance and innovation fatigue (Freichel et al., 2022; Vlachos, 2021b). At the systems level, ERP platforms are often not designed for dynamic supply chain environments (Seethamraju, 2009), and without proper integration between systems, visibility remains out of reach (Howard et al., 2005; Suherman & Simatupang, 2017). Budget constraints add to this, as investment in new visibility technologies is often difficult to justify internally (Freichel et al., 2022; Kalaiarasan et al., 2022). At the data level, poor master data quality is a persistent obstacle (de Oliveira & Handfield, 2019): unreliable information spreads errors across the supply chain (Chaffin et al., 2024; Kalaiarasan et al., 2022), and resolving it requires cross-functional alignment that is rarely straightforward (Ahmed & Omar, 2019; Freichel et al., 2022;

Liotine, 2019b). Finally, at the governance level, lack of standardization creates incompatibilities with legacy systems and partner platforms, while insufficient incentives for information sharing can lead to data distortion across the network (Freichel et al., 2022; Howard et al., 2005; Vlachos, 2021b).

Beyond the framework, Vlachos (2021b) highlights three additional challenges: top management resistance, which can cause delays even when leadership initially expresses support; a skills and talent gap, as CT environments demand problem-solving and complexity-management capabilities that traditional supply chain roles do not develop; and insufficient integration between systems, processes, and people, without which the expected benefits cannot be fully realized.

3.6.1 Organizational and Change Management Challenges

What the barriers described above have in common is that they are ultimately shaped by people, not systems. Research suggests that approximately 50% of CT initiatives fail to meet their objectives due to challenges in implementation, integration, and scalability (Siena et al., 2024), and that 90% of implementation problems are rooted in processes and human factors (Howard et al., 2005). The technology, in most cases, is not what breaks a CT deployment.

This is why a CT must be managed as a socio-technical system, where performance emerges from the interaction between the technology and the people operating it, not from the technology alone (Vlachos, 2021b). Strategic change management is what bridges that gap: by generating early wins, building organizational buy-in at every level, and aligning personnel and processes around a new way of working, companies can create the conditions for the CT to deliver what it promises (Freichel et al., 2022; Vlachos, 2021b).

The change management literature offers several frameworks to guide this process. Among the most widely cited are Lewin's three-stage model (Lewin, 1947) and Kotter's eight-step process (Kotter, 1996). While Lewin provides a useful conceptual lens for understanding why change encounters resistance, Kotter's framework is more widely adopted in practice due to its structured and actionable nature, making it particularly well suited to complex implementations such as a CT deployment. The following section presents Kotter's model in detail.

Kotter's Eight-Step Model for Change Management

Kotter's eight-step model proposes that successful organizational change is not a single event but a structured process that must be carefully sequenced and managed. Each step builds on the previous one, and skipping any of them significantly increases the risk of failure. The eight steps presented below are drawn entirely from Kotter's foundational work Kotter, 1996:

- *Step 1 — Establish a Sense of Urgency*: Change rarely happens when people feel comfortable. The first step is making the case that the status quo is no longer viable: surfacing the risks, inefficiencies, or missed opportunities that make doing nothing more dangerous than changing. Without a genuine sense of urgency, the effort required to transform an organization will simply not materialize.

- *Step 2 — Build a Guiding Coalition*: No single leader can drive a complex transformation alone. A guiding coalition brings together people with the positional power, technical expertise, and organizational credibility needed to lead the change. This is not a passive committee, it is a group united by shared conviction and capable of overcoming the inertia that resists any departure from the established way of doing things.

- *Step 3 — Develop a Vision and Strategy*: A clear, compelling vision of the future gives people a reason to move in a new direction. Kotter emphasizes that this vision must be simple enough to be communicated in under five minutes, not a technical document but a picture of where the organization is headed and why it is worth the effort of getting there. A good vision also empowers people to make decisions independently, without needing approval for every small step.

- *Step 4 — Communicate the Change Vision*: A vision that is communicated once and then forgotten changes nothing. Leaders must embed the new direction into every available channel (meetings, emails, day-to-day decisions) and, critically, they must model the behaviors they are asking others to adopt. People will only believe the change is real when they see their leaders living it.

- *Step 5 — Empower Broad-Based Action*: Even when people want to change, structural barriers can stop them. This step is about removing the obstacles (outdated processes, rigid systems, resistant managers) that prevent people from acting on the new vision. Empowerment also means providing the training and tools people need to operate effectively in the new environment.

- *Step 6 — Generate Short-Term Wins*: Long transformation journeys are exhausting, and skepticism grows quickly when results are not visible. Planning and celebrating early, tangible wins serves a dual purpose: it validates the strategy and silences critics who might otherwise undermine the effort. Short-term wins are not a distraction from the long-term goal, they are the fuel that keeps the organization moving toward it.

- *Step 7 — Consolidate Gains and Produce More Change*: One of the most common mistakes in change management is declaring victory too soon. Early wins create momentum, but the deeper structural and cultural changes take longer. This step is about using the credibility earned through early successes to tackle the more entrenched problems, the interdependent systems and habits that are still anchored in the old way of working.

- *Step 8 — Anchor New Approaches in the Culture*: Change is only permanent when it becomes the way things are done here. The final step is making the new behaviors and processes part of the organization's identity showing explicitly how they have improved performance, and ensuring that new people joining the organization are trained under the new standards from the start. Without this anchoring, organizations tend to drift back to their old habits once the initial pressure to change subsides.

The model has a sequential nature and the process is cumulative, each step creates the conditions for the next, and progress through the later stages depends on having built a solid foundation in the earlier ones (Kotter, 1996).

3.7 Data Requirements and Data Quality in CTs

A CT is only as good as the data that feeds it. As highlighted by de Oliveira and Handfield (2019), analytical capabilities have little impact unless they are built upon clean, reliable, and timely data. Likewise, Vlachos (2023) emphasizes that "data is at the core of the CT", and that sharing unreliable or inaccurate information can have severe consequences for supply chain projects. Without accurate, timely, and complete information flowing into the system (Hazen et al., 2014; Williams et al., 2013), the MAPE-K loop explained in Chaper 3.4, has nothing meaningful to work with as it cannot monitor what it cannot see, analyze what it does not know, or plan responses based on information it cannot trust. This makes data not just a technical prerequisite, but the foundation on which the entire CT proposition rests.

The following sections examine in the literature what types of data a CT requires to function effectively, what quality standards that data must meet, and what challenges organizations typically face when trying to bring it all together.

3.7.1 Data Requirements

A CT requires several categories of data to maintain a reliable and panoramic picture of the supply chain (Kalaiarasan et al., 2022). Rather than relying on isolated data streams, it acts as a centralized hub or "single source of truth" that aggregates and interconnects information from multiple disparate sources across the network (Kalaiarasan et al., 2022). This integration is fundamental for extracting critical execution information and providing the necessary visibility for both short and long-term decision-making (Kalaiarasan et al., 2022).

- Transactional and Order Data (Capgemini, 2011; Liotine, 2019a): PO and SO, invoices, and shipping documentation flowing from ERP systems form the operational backbone of the CT. Without this data, the system has no reference point to detect deviations or trigger alerts.
- Inventory Visibility (Capgemini, 2011; Harmelink, Topan, & van Hillegersberg, 2025; Liotine, 2019a): Real-time stock levels at every node (warehouse and in-transit at SKU level) allow the CT to track availability and catch shortages before they turn into service failures.
- Logistics and Transport Data (Capgemini, 2011; Harmelink, Merrienboer, et al., 2025; Liotine, 2019a): GPS tracking, lane capacities, and estimated arrival times give the system the visibility it needs to monitor flows, spot consolidation opportunities, and support routing decisions.
- Regulatory and Quality Data (Liotine, 2019a): Depending on the industry, the CT may also need to track regulatory approval statuses and quality excursions to ensure that operational decisions respect applicable standards and contractual obligations.
- Performance Metrics (KPIs) (Harmelink, 2022; Harmelink, Topan, & van Hillegersberg, 2025; Liotine, 2019a): Fill rates, lead times, and carrier reliability data translate day-to-day operations into measurable SLA compliance, making it possible to identify where the network is underperforming before it becomes a problem for the company.

3.7.2 Data Quality Dimensions

The performance of a CT is strictly predicated on the intelligent use of quality data (Chaffin et al., 2024). The literature establishes that poor data quality serves as the root cause of many issues, as it triggers incorrect information calculations and leads to flawed managerial decisions (Chaffin et al., 2024; Gunasekaran et al., 2021). If the data feeding the system is incomplete or incorrect, the CT loses its ability to make decisions or take actions "on the fly" (Liotine, 2019a). To ensure the information is fit for operational use, it must satisfy four critical dimensions: it must be accurate, timely (real-time), complete, and in usable formats (de Oliveira & Handfield, 2019; Kalaiarasan et al., 2022) .

- Accuracy, Timeliness, and Completeness: One of the most cited quality standards established in Williams et al., 2013 note that for information to be fit for use, it must be accurate, timely, complete, and presented in usable formats. These three attributes form the baseline against which data quality in any CT context is measured.
- Consistency and Validity (Chaffin et al., 2024; Siena et al., 2024): Beyond individual accuracy, data must be consistent across the entire supply chain network. When different partners or sites are working from conflicting information, the CT cannot produce a coherent picture and decisions made on that basis will compound rather than resolve the problem.

- Operational Reality and Latency (de Oliveira & Handfield, 2019): Information must reflect the physical reality of the supply chain in near real-time. System latency, the gap between what is happening and what the CT can see, directly limits the speed at which planners can respond to disruptions.
- Granularity (Gunasekaran et al., 2021; J. Patsavellas et al., 2022): A high level of detail is required to detect "weak signals" of disruption before they escalate into larger problems. Aggregated data may be easier to manage, but it tends to obscure the early indicators that would allow the system to intervene proactively.
- Veracity and the Trust Factor (Chaffin et al., 2024; de Oliveira & Handfield, 2019; Gunasekaran et al., 2021): Data quality is ultimately the foundation of user trust. If decision-makers cannot rely on the integrity of what the system produces, they will disregard its recommendations and revert to manual, experience-based decisions which defeats the purpose of having a CT in the first place.
- Readability and Accessibility (Harmelink, 2022): Quality also encompasses how easily data can be interpreted by human operators or processed by automated agents. Information that exists but cannot be readily accessed or understood adds little value to the system.

3.7.3 Data Integration Challenges

Even though the previous chapters identified the data and its quality standards required by the CT, this does not guarantee that data will flow reliably across the network (de Oliveira & Handfield, 2019). In practice, consolidating a single source of truth from multiple systems, partners, and organizational units is one of the most demanding aspects of CT implementation, with estimates suggesting that up to 50% of initiatives fail due to integration-related challenges, as highlighted in the cited study Siena et al., 2024. The barriers are not purely technical: while system connectivity is a significant challenge, the organizational and strategic dimensions of data integration are often equally, if not more, difficult to resolve (Gunasekaran et al., 2021; Harmelink, Topan, & van Hillegersberg, 2025). In addition to the barriers identified in Chapter 3.7, focusing now on those related to data, the literature identifies the following as the most significant obstacles:

- Information Silos and Data Heterogeneity (de Oliveira & Handfield, 2019; J. Patsavellas et al., 2022): Traditional enterprise software tends to accumulate data in disconnected compartments, making a holistic view difficult to achieve. Data arrives in vastly different formats: structured databases, semi-structured files, and unstructured text, which further complicates consolidation.
- Semantic Heterogeneity (Dautov, 2016; Harmelink, 2022): Even when data is technically accessible, different partners often use different terms for the same operational concepts. Without a common vocabulary, the CT's knowledge base becomes inconsistent and unreliable.
- Legacy Systems and Lack of APIs (Harmelink, 2022; Harmelink, Merrienboer, et al., 2025; Howard et al., 2005): Many organizations depend on older infrastructure that lacks the modern Application Programming Interfaces needed for real-time connectivity. Without them, the CT cannot access the data it needs at the speed it requires.
- Manual Processes and Human Error(Gunasekaran et al., 2021; Howard et al., 2005; Schenk & Clausen, 2020; Siena et al., 2024): Despite digital advances, many activities still rely on manual communication: email, telephone, spreadsheets. This introduces data gaps, inaccuracies, and latency that undermine the CT's ability to reflect operational reality.
- Resistance to Data Sharing and Lack of Trust (Gunasekaran et al., 2021; Harmelink, 2022; J. Patsavellas et al., 2022; Siena et al., 2024): Collaboration is often stalled by concerns about losing competitive advantage

or by undefined data ownership rules. There is also a risk of trust inversion, where external partners hesitate to share strategic information with an entity that now centralizes control over the network.

- Costs and Skillset Constraints (Liotine, 2019a; J. Patsavellas et al., 2022): Implementation requires significant financial investment and time, compounded by a shortage of personnel with the expertise to design and manage complex data architectures.
- Technological Disparities (Freichel et al., 2022; Liotine, 2019a; J. Patsavellas et al., 2022): Trading partners often operate at very different levels of digital maturity, which complicates scalability and makes it difficult to build integrations that work consistently across the network.

3.8 Performance Measurement and KPIs in CTs

A CT that cannot measure its own impact cannot demonstrate its value, and without demonstrated value, it will not sustain the organizational support it needs to survive. The literature frames performance measurement in a Supply Chain CT around the *"3M functionality"* as highligthed in study J. Patsavellas et al., 2022: Monitor, Measure, and Manage. This structure captures something important: the CT's purpose is not just to collect data, but to turn it into decisions that actually change how the supply chain operates (Capgemini, 2011; Trzuskawska-Grzesińska, 2017). Without a clear measurement framework, that translation never happens, the system produces information, but nobody is accountable for acting on it.

KPIs matter for a reason that goes beyond performance tracking. They are what make the CT's contribution visible to the organization showing where things improved, by how much, and why (Trzuskawska-Grzesińska, 2017). They also build trust: when people can see that the system's alerts led to better outcomes, they start relying on it instead of working around it (Trzuskawska-Grzesińska, 2017). This is particularly important in the early stages of implementation, when organizational resistance is highest and the CT's credibility is still being established.

The literature organizes CT performance measurement into four foundational dimensions (**ref4**): agility, resilience, reliability, and responsiveness, each capturing a different aspect of how well the supply chain adapts, recovers, delivers, and responds. Building on these, specific KPIs are grouped into five areas: operational and delivery metrics, service-oriented metrics, financial and strategic indicators, sustainability and risk measures, and the data quality standards that underpin them all.

3.8.1 Core Performance Dimensions

Before defining specific KPIs, the literature establishes four foundational dimensions that reflect what an effective CT must deliver, as explained in the study Capgemini, 2011. These are not individual metrics, they capture the broader qualities that determine whether the supply chain is performing as it should:

- Agility: The capacity to change processes, partners, or goals with minimal delay when conditions shift without waiting for manual escalation.
- Resilience: The ability to absorb and recover from uncontrollable disruptions with minimal operational impact, keeping service commitments intact even when things go wrong.
- Reliability: The consistency of meeting commitments on quality, timeliness, cost, and availability that makes the CT something the organization can genuinely count on.
- Responsiveness: The speed at which the system captures information and adapts to changes in demand, regulation, or competition. In a volatile environment, this often determines whether a problem gets resolved or escalated.

Together, these four dimensions provide the foundation for the specific KPIs that follow, defining not just what to measure, but what kind of supply chain behavior the CT is designed to enable.

3.8.2 Key Performance Indicators

Defining what to measure is as important as building the system itself (Chaffin et al., 2024). The literature organizes CT performance metrics across multiple operational and strategic dimensions, reflecting of what a well-functioning CT must oversee. Central to this measurement framework are SLA, which are defined as service contracts between at least two parties (a provider and a receiver) that explicitly specify the service being delivered and the KPIs used to quantify its success (Harmelink, 2022). These agreements serve as the legal and operational foundation for collaboration, establishing critical rules for service delivery, compensation, and performance thresholds, such as guaranteed lead times or specific asset availability targets (Harmelink, 2022).

The following Table 5 consolidates the key indicators identified in the literature, grouped by functional area from delivery and logistics to sustainability and CT productivity. Together, they provide the measurement framework through which the CT's impact can be tracked, communicated, and continuously improved.

Table 5: KPIs in CTs

Area	**KPIs and Metrics**	**Source**
Delivery	Customer Logistics Index Performance, Requested Logistics Improvement Performance, Delivery Reliability, On-Time and In-Full Orders, Agreed Delivery Date Performance	(Freichel et al., 2022; Schenk & Clausen, 2020; Trzuskawska-Grzesińska, 2017)
Logistics Operations	Logistics Delay Times, Carrier On-Time Performance, Throughput Time, Transit Times, Estimated Time of Arrival Prediction	(Capgemini, 2011; Freichel et al., 2022; Liotine, 2019a; Trzuskawska-Grzesińska, 2017)
Inventory	Inventory Turnover, Days of Cover, Aging Stock, Blocked Stock, In-Transit Inventory at SKU Level	(Capgemini, 2011; Chaffin et al., 2024; Trzuskawska-Grzesińska, 2017)
Production	Order Lead Time, Production Cycle Time, Adherence to Schedule, Resource Utilization	(Liotine, 2019a; Nadar et al., 2025; Trzuskawska-Grzesińska, 2017)
Service and Maintenance	Asset Availability, Downtime, Re-repair Rate, Parts Usage Efficiency, Obsolescence Management	(Harmelink, 2022; Harmelink, Topan, & van Hillegersberg, 2025; Trzuskawska-Grzesińska, 2017)

Area	**KPIs and Metrics**	**Source**
Finance and Strategy	Total Landed Cost, Operating Costs, Working Capital, ROI, Decision Automation Savings	(Capgemini, 2011; de Oliveira & Handfield, 2019; Liotine, 2019a; Trzuskawska-Grzesińska, 2017)
Quality and Risk	Quality Excursions, Damaged Units, Forecast Accuracy, Weak Signal Detection, Incident Resolution Time	(Liotine, 2019a; J. Patsavellas et al., 2022; Trzuskawska-Grzesińska, 2017)
Communication	Customer Satisfaction, Ticket Responsiveness, Partner Collaboration Level	(J. Patsavellas et al., 2022; Trzuskawska-Grzesińska, 2017)
Sustainability	CO2 Emissions, Fuel Consumption per Ton, GHG Limit Compliance	(Din et al., 2026; Harmelink, 2022; R. Verma et al., 2020)
CT Productivity	Uncovered Exceptions, Time Between Deviation and Alert, System Recommendation Accuracy	(Harmelink, 2022; Liotine, 2019a; Trzuskawska-Grzesińska, 2017)

Beyond the individual metrics, the literature highlights three cross-cutting findings worth noting. First, successful CT implementations have demonstrated reductions of 10–20% in total supply chain costs and 3–5% in logistics-specific costs, with inventory level reductions of 5–15% and reported ROIs of up to 212% (Junior et al., 2025). Second, decision automation, where 50–70% of rules-based decisions are handled by the system, reduces decision time from days to seconds, representing one of the most significant operational gains a CT can deliver (G. A. Smith, 2022). Third, and critically, no metric is valid unless the underlying data meets the quality standards established in the previous section: accurate, timely, complete, and usable (de Oliveira & Handfield, 2019; Siena et al., 2024). A KPI built on poor data does not measure performance, it measures noise.

3.9 Critical Success Factors of CT

Critical Success Factors (CSFs) refer to the key conditions or elements that must be effectively managed in order for a project or organizational initiative to achieve its objectives. The concept has been widely applied in management and information systems research, where CSFs are understood as the limited number of areas in which satisfactory performance ensures overall success (Denolf, Trienekens, Wognum, et al., 2015). By identifying these factors, organizations can prioritize resources and managerial attention on the aspects that most strongly influence performance, while avoiding dispersion of efforts on less critical issues.

In the context of CTs, the identification of CSFs is particularly relevant. Implementing an CT involves the integration of people, processes and technology across multiple organizational levels and supply chain partners. Such complexity increases the risk of misalignment, resistance, or ineffective system use. A clear understanding of the factors that drive successful implementation therefore supports better coordination, stronger collaboration, and more informed decision-making across the network (Denolf, Trienekens, Wognum, et al., 2015).

To consolidate the most relevant CSFs in this field, Chaffin et al. (2024) conducted a systematic literature review of 47 peer-reviewed articles covering diverse research domains, including marketing and logistics, strategy and management, business systems, and information systems. Through this cross-disciplinary analysis, the authors identified the factors most frequently associated with high-performing CTs.

The table that follows synthesizes these findings and indicates how often each CSF appears in the literature. By highlighting areas of convergence across studies, it provides a structured and evidence-based foundation for analyzing which factors are most influential in enhancing CT performance and long-term supply chain resilience.

Table 6: Most Frequently cited CSFs in the Literature (n=47), based on the systematic review conducted by Chaffin et al. (2024)

Critical Success Factor	Frequency	Percentage
Technology Infrastructure	44	94%
Data Quality	43	91%
Advanced Analytics	41	87%
Information Sharing	40	85%
Human Capital	36	77%
Supply Chain Integration	35	74%
Top Management Commitment	29	62%
Relationship Management	25	53%
Organizational Readiness	23	49%
Standardization	23	49%
Alert Generation	22	47%
Data Security	22	47%
Digitalization	17	36%
Partner Trust	13	28%

Among the CSFs listed in Table 6, the most frequently cited are Data Quality, Advanced Analytics, Technology Infrastructure, Digitalization, Information Sharing, Top Management Commitment, Supply Chain Integration and Standardization. These factors are essential for CT performance because they ensure that data collected from different parts of the supply chain is accurate, reliable and timely, that technological tools and infrastructure support effective processing and analysis, and that all supply chain partners are aligned and able to collaborate efficiently (Brinch, 2018a; Fearne, 2021; Patil, 2023; Vlachos, 2021a; Xu & Pero, 2023).

Data Quality is fundamental for CTs, as reliable, timely and accurate information supports predictive analytics, status monitoring and alert generation, facilitating agile decision-making and risk mitigation (Kache & Seuring, 2017; Lamba & Singh, 2018; Maheshwari, 2023; Oliveira & Handfield, 2022).

Advanced Analytics transforms raw data into actionable insights, allowing firms to anticipate disruptions, optimize processes and plan strategically (Dey, 2023; A. Patsavellas, 2021; J. Smith, 2022).

Technology Infrastructure and Digitalization provide the necessary backbone for CT operations, integrating heterogeneous IT systems, enabling automated workflows and ensuring end-to-end supply chain visibility (Küffner, 2022; Sony & Naik, 2020).

Information Sharing and Supply Chain Integration ensure that data and knowledge move smoothly and quickly between all partners, avoiding delays, misunderstandings4 or overstocking problems, and helping different parts of the supply chain work together more efficiently (Ivanov & Dolgui, 2021; A. Patsavellas, 2021; P. Verma, 2020).

Top Management Commitment is crucial for CT adoption, providing resources, supporting change management and fostering alignment across participating organizations (Denolf, Trienekens, Wognum, et al., 2015; Ngai & Gunasekaran, 2007). Finally, Standardization of processes, protocols and data formats enhances interoperability and ensures consistency across the network (S. Bhosle, 2011; Brinch, 2018a; Vlachos, 2021a).

In practice, these CSFs are interconnected: technology enables data-driven insights, management commitment ensures adoption and resource allocation, and standardization facilitates scalability and interoperability. By prioritizing the factors most frequently cited in the literature, organizations can strengthen CT performance, improve visibility and responsiveness, and increase overall supply chain resilience (Richey, 2016; Xu & Pero, 2023).

The CSFs identified above serve as the analytical foundation for the evaluation conducted in Chapter 5. The factors most frequently cited in the literature such as Data Quality, Technology Infrastructure, Information Sharing, Top Management Commitment, and Organizational Readiness, are not abstract concepts in Lindab's case: they translate directly into concrete questions about master data reliability, system fragmentation, cross-site collaboration, and the organizational willingness to change. Keeping these factors in mind throughout the analysis allows the evaluation to go beyond a descriptive diagnosis and assess whether Lindab has or can realistically develop the conditions that the literature consistently associates with successful CT adoption.

4 Empirical Data

This chapter presents the empirical data collected for the thesis, mainly obtained through interviews, which serve as the basis for the analysis and conclusions. It also provides an overview of the company's logistics, with particular emphasis on the pilot currently being carried out. Finally, the chapter identifies the main challenges, as well as the expectations and needs for the implementation of the CT, gather through the interviews.

4.1 Current Logistics Challenges at Lindab

This section discusses the main challenges in the company's current logistics set-up, focusing on the issues most frequently mentioned during the interviews.

4.1.1 Decentralized Organizational Structure

One of the most frequently mentioned problems by the interviewees in the logistics domain is the decentralization of the company, specifically highlighted by *Interviewees E, F, J, K, M, N, O and Q*. As *Interviewees J and E* describe, the company initially started with the idea of a centralized structure, but over time, due to management changes, it shifted toward a more decentralized model. This model works well in many areas; however, in logistics, it continues to be a challenge. According to interviewee J: *"The decentralized system can work in some areas, but when it comes to logistics, it is better to work together."*

The silo structure causes each company to operate autonomously, without considering what other companies are doing. This often leads to decisions that benefit individual companies but not the organization as a whole. As *Interviewee K* points out: *"One unit can make a decision that benefits itself but negatively affects another"*. This leads to fragmented decision-making, as *Interviewee O* explains, central units can provide guidelines on how to operate efficiently; however, execution authority remains within local departments. *Interviewee O* illustrates this by stating that *"Sometimes they should buy internally, but they buy externally because most of the focus in the Lindab Group is on the local result"*. *Interviewee L* further adds that shipments are not always sent from the most suitable branch due to the lack of coordination resulting from this decentralized way of operating.

This lack of coordination and fragmented decision-making creates a notable effect on the company's logistics operations through the under utilization of transport capacity. As stated by *Interviewee L*, *"trucks leaving here often have a lot of free space."* This issue is closely related to the decentralized structure of the organization, in which different units plan and execute shipments independently without considering overall transport capacity. As a result, trucks frequently depart with unused space, highlighting a clear opportunity to improve shipment consolidation and transport efficiency.

This also extends to inventory management, as described by *interviewees F, K, Q and N*. Due to decentralization, inventory visibility is limited. *Interviewee Q* states: *"everyone owns their own stock levels"* and supported by *Interviewee F* that explains: *"Local warehouses have autonomy over replenishment decisions and often maintain 30–45 days of stock to avoid stock outs"*. This causes an inefficient inventory management and highlights the need for greater coordination as *Interviewee Q* states: *"we would need a multi-echelon inventory optimization system to decide where we should store and stock products"*. *Interviewee K and Q* further support that this situation generates significant financial losses due to obsolete products. As Lindab manages many small, slow-moving items, obsolete products have to be handled properly. *Interviewee Q* summarizes this issue by stating that *"Each site does not have very much stock individually, but together across many sites it still adds up to a lot of money tied up in an old product that we don't want anymore."*.Also, another effect, it's the duplicated stock and suboptimal planning, as explained by *Interviewee N* the lack of coordination creates blind spots that results in inefficiencies that affects working capital and service levels in the stock management.

All of this highlights the need for an overall view of what is happening at the company level and for improving cooperation, so that each site does not operate in isolation. As *Interviewee N* emphasizes: *"Finding the balance between local responsibility and central oversight is critical".*

4.1.2 Data Quality

Another widely discussed challenge among the interviewees is data, particularly highlighted by *interviewees D, F, G, H, Q and J*. Specifically, issues related to master data quality were consistently mentioned by the interviewees. As *interviewees F* states: *"Master data inconsistencies, missing packaging dimensions, and incorrect stock volumes are common".*

Regarding packaging data, *interviewee H* states that *"the absolute biggest and almost only challenge is that Lindab does not have clear data on how their items end up in pallets, boxes, or other packaging."* Gathering this information is particurarly difficult because the company has many different types of packaging, according to *interviewee Q "we can have the same products in five or six different packaging types depending on customer requirements."* This missing data affects stock levels and forecasting as *interviewee Q and F* state, as the system does not provide enough visibility regarding packaging formats and inventory quantities. In addition, *interviewee F* adds that it also creates challenges for transport planning, and *interviewee Q* supports by explaining that *"we don't know in advance how many pallets there will be, we get an order from customers, and then the picker decides how many pallets are needed."* As a result, it becomes difficult to determine truck volumes and available capacity in advance.

Another important issue concerns stackability. Due to the characteristics of certain products, some items can be placed inside others. However, as pointed out by *interviewee D*, this type of information is not included in the system, which limits the possibility of full automation. Similarly, *interviewee Q* states that this knowledge is in the workers knowledge, *"You need to know what is possible to stack and what is not, and that knowledge is not in the master data, it is in the heads of the transport planners."*
Overall, these data limitations reduce visibility across the supply chain, leading to less reliable analytics and forecasting, and ultimately affecting replenishment and transport planning, as indicated by *interviewee F*.

Currently, these issues are often managed through manual corrections, particularly in Domestic Local Warehouses. There is still a strong dependence on experienced employees to interpret and manage the data, which prevents full automation. As *interviewee H* explains: *"The data quality is good in the sense that someone trained and familiar with Lindab and their products can use it, but the computer cannot, because it's not that obvious."* So, it is still a work in progress. Even if the system itself is well designed, inaccurate or incomplete data can lead to incorrect analyses and decisions. Therefore ensuring reliable data is essential for the success of such a system.

4.1.3 Fragmented Systems

Lindab has primarily grown through acquisitions rather than establishing its own facilities, which has resulted in many acquired companies continuing to use their own systems. This challenge is highlighted by *interviewees G and N*. In particular, *interviewee N* states that *"central units had full visibility thanks to ERP systems, but units operating on separate ERPs lacked access, creating blind spots."* In line with this, *interviewee G* adds that this situation creates data silos, meaning that data is stored in different formats and structures, making consolidation and analysis difficult. As a result, information often needs to be requested manually, and the data must be cleaned and standardized before it can be effectively used.

In this context, the company is currently working on a project to standardize ERP systems across the entire organization, as discussed by *interviewee J*. This initiative started in January 2026 in France, and as more companies adopt the system, the company expects to gain visibility.

4.1.4 Summary of Challenges

To provide a structured overview of these findings, Table 7 summarizes the main root causes identified during the interviews, together with their associated operational effects and observable symptoms. The table also includes the mention frequency of each issue among interviewees, highlighting the challenges perceived as most critical within the organization.

Table 7: Summary of challenges identified through interviews

ROOT CAUSE	FREQUENCY	OPERATIONAL EFFECT	SYMPTOMS
Decentralized structure	**53%**	Lack of transport coordination between business units and different sites	Shipments are not dispatched from the optimal branch
			Trucks operate with low fill rates
			Unnecessary inter-branch transfers
			Limited shipment consolidation
	47%	Lack of inventory coordination	Duplicated inventory across warehouses
			Excess safety stock levels to avoid local stock-outs rather than optimize globally
			Slow-moving inventory accumulation
			Obsolete inventory accumulation
			Independent replenishment decisions across warehouses
	40%	Fragmented decision-making	Difficulty implementing group-wide initiatives
			Sites prioritize local objectives over group efficiency
			Local departments retain execution authority despite central guidelines

ROOT CAUSE	FREQUENCY	OPERATIONAL EFFECT	SYMPTOMS
Poor data quality	**60%**	Limited end-to-end supply chain visibility	Blind spots across warehouses and business units
			Incorrect stock quantity records
	47%	Reduced transport planning accuracy	Missing packaging data
			Missing stackability data
			Unknown pallet configuration before shipment
			Inability to accurately calculate truck fill rates
			Frequent manual adjustments during transport planning
	47%	Limited automation capability	High dependency on worker knowledge and experience
			Paper-based or partially manual operational processes
	33%	Reduced forecasting reliability	Inaccurate demand forecast
			Inconsistent analytical outputs
Fragmented IT landscape / Multiple ERP systems	**20%**	Data silos and inconsistent information flows	Different sites operate with separate ERP systems
			Manual data consolidation required
			Inconsistent reporting formats and units
			Limited data sharing across entities

4.2 Transport Utilization Inefficiencies

While the interviews identified several current challenges within the company's logistics operations, this section provides a quantitative analysis of one of the key issues that motivated the implementation of a CT: low truck utilization rates.

4.2.1 International Transport Optimization Analysis

For this purpose, 2025 shipment data was analyzed for flows between the facilities in Bjäre, Sweden, and the various destination countries served by the network. The analysis focuses on shipments dispatched from the central facilities and considers the three business units located there: Ventilation, Steel, and Profile. It is worth noting that last-mile deliveries to end customers are excluded from this analysis even though this represents a relevant area for further investigation, as routing shipments through local branches rather than direct delivery could offer additional consolidation opportunities for Lindab.

Following this approach, the number of shipments to each country was calculated and categorized according to the truck capacity utilized, expressed in LDM, which represents the loading space occupied in the truck.

Table 9: Shipment distribution by LDM range and country (Part 1)

Shipment Distribution by LDM Range and Country	**IE**	**CH**	**BE**	**EE**	**UK**	**FR**
A 0.1–0.9	24%	0%	1%	0%	9%	8%
B 1.0–1.9	11%	0%	1%	0%	7%	9%
C 2.0–2.9	7%	0%	1%	0%	3%	5%
D 3.0–3.9	22%	0%	10%	1%	5%	3%
E 4.0–4.9	4%	0%	10%	1%	4%	2%
F 5.0–5.9	7%	0%	8%	2%	5%	4%
G 6.0–6.9	11%	2%	14%	1%	5%	4%
H 7.0–7.9	2%	2%	8%	4%	3%	5%
I 8.0–8.9	4%	2%	11%	4%	5%	5%
J 9.0–9.9	4%	8%	8%	5%	9%	3%
K 10.0–10.9	4%	12%	1%	10%	9%	6%
L 11.0–11.9	0%	5%	3%	8%	14%	8%
M 12.0–12.9	0%	14%	3%	38%	2%	5%
N 13.0–13.6	2%	56%	21%	25%	22%	33%
Total Shipments	**55**	**59**	**73**	**166**	**195**	**216**

Table 10: Shipment distribution by LDM range and country (Part 2)

Shipment Distribution by LDM Range and Country	**PL**	**DE**	**FI**	**DK**	**CZ**	**NO**
A 0.1–0.9	8%	56%	12%	3%	0%	7%
B 1.0–1.9	8%	12%	3%	4%	3%	8%
C 2.0–2.9	7%	4%	2%	8%	5%	7%
D 3.0–3.9	7%	3%	2%	3%	3%	6%
E 4.0–4.9	7%	2%	2%	3%	3%	7%
F 5.0–5.9	7%	1%	2%	4%	5%	5%
G 6.0–6.9	8%	1%	3%	2%	4%	5%
H 7.0–7.9	8%	0%	5%	3%	4%	5%
I 8.0–8.9	8%	1%	5%	5%	4%	5%
J 9.0–9.9	5%	1%	6%	5%	5%	5%
K 10.0–10.9	6%	1%	6%	4%	5%	5%
L 11.0–11.9	10%	0%	5%	8%	9%	6%
M 12.0–12.9	3%	3%	3%	5%	2%	4%
N 13.0–13.6	6%	16%	43%	44%	48%	25%
Total Shipments	**250**	**388**	**393**	**548**	**700**	**1246**

As shown in Table 9 and 10, the distribution of truck fill rates varies significantly across destination countries. However, a consistent pattern can be observed across the network: a substantial proportion of shipments are transported below optimal truck capacity. As a summary, Table 11 and Figure 11 present the overall percentage distribution of shipments by truck capacity range. This indicates a high level of shipment fragmentation and highlights the presence of inefficiencies in transport planning.

Table 11: Distribution of shipments by chargeable weight range (LDM)

Chargeable Weight Range (LDM)	**Number of Shipments**	**Share of Total Shipments**
A 0.1–0.9	429	10%
B 1.0–1.9	249	6%
C 2.0–2.9	238	6%
D 3.0–3.9	192	4%
E 4.0–4.9	181	4%
F 5.0–5.9	182	4%
G 6.0–6.9	172	4%
H 7.0–7.9	177	4%
I 8.0–8.9	196	5%
J 9.0–9.9	208	5%
K 10.0–10.9	225	5%
L 11.0–11.9	290	7%
M 12.0–12.9	213	5%
N 13.0–13.6	1337	31%
Total Shipments	**4289**	**100%**

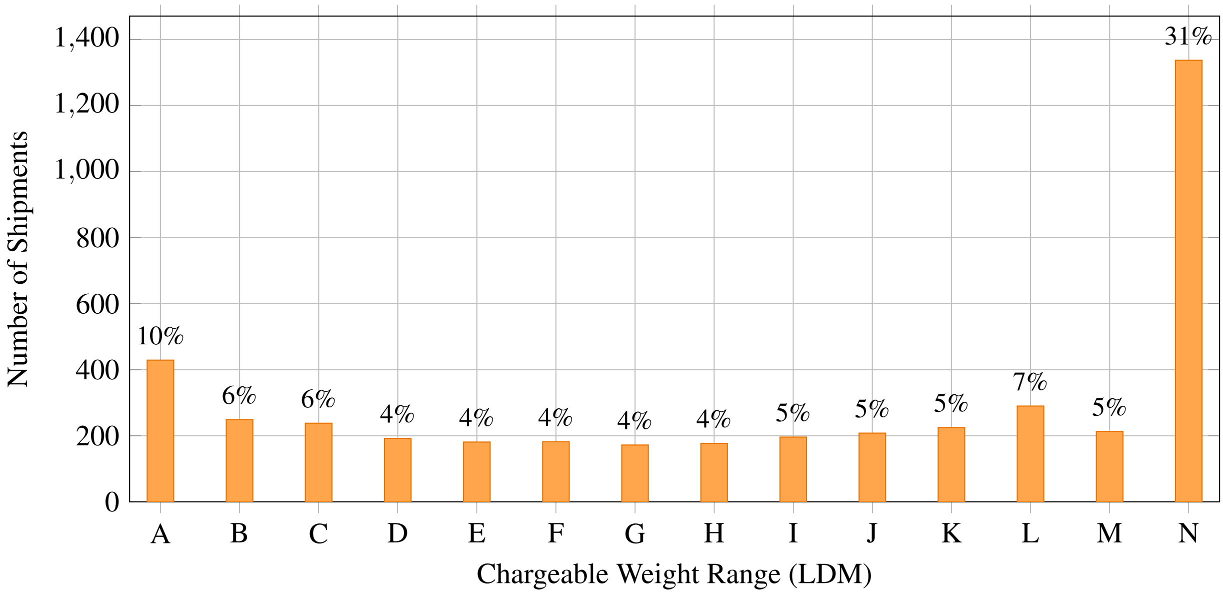


Figure 11: Distribution of shipments by chargeable weight range (LDM)

Based on this analysis, an estimation has been conducted to determine the ideal number of shipments required assuming truck utilization at maximum capacity, shown in Figure 12.

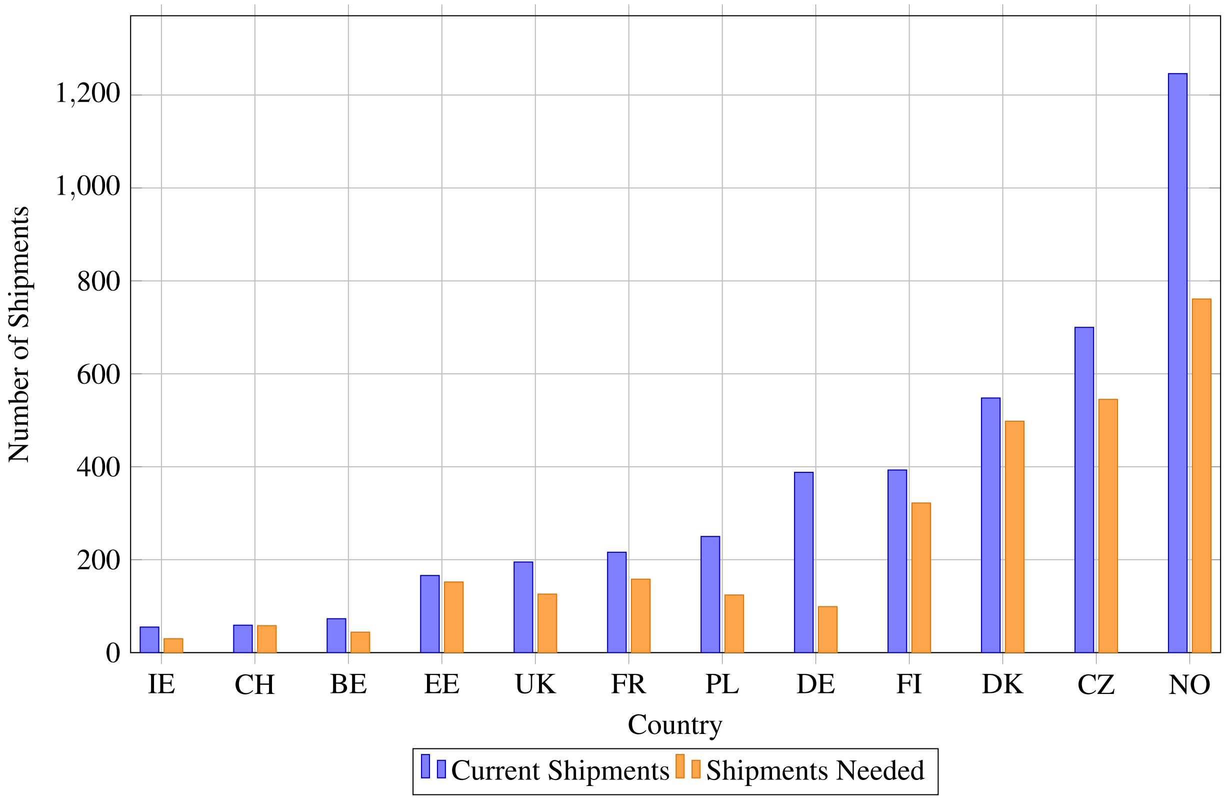


Figure 12: Comparison between current shipments and shipments needed by country

Table 12: Potential shipment reduction by country

Country	Current Shipments	Shipments needed	Reduction (%)
IE	55	30	-45%
CH	59	58	-1%
BE	73	44	-39%
EE	166	152	-8%
UK	195	126	-35%
FR	216	158	-26%
PL	250	124	-50%
DE	388	99	-74%
FI	393	322	-18%
DK	548	498	-9%
CZ	700	545	-22%
NO	1246	761	-39%
TOTAL	**4289**	**2917**	**-32%**

This calculation represents an ideal scenario that is not fully achievable in practice. Several factors affect the possibility of consolidation in each country:

- Trucks are often pre-booked according to agreed weekly delivery schedules.
- Geographical constraints, such as long distances between sites, limit consolidation opportunities.
- Service requirements must still be met, including strict lead times and high service levels, which may prevent demand from being aligned with a limited number of annual full shipments.

Therefore, to obtain a more realistic estimation, an approximation was made for each country, taking into account the specific constraints in each case. To do so, a savings percentage was applied to the current spend, taking into account the maximum potential savings. This calculations in total correspond to estimated savings of **14%** of the current spend per year, representing a substantial reduction in transport costs.

It should be noted that, as previously discussed, these results are based on assumptions. However, they provide a valuable starting point for further analysis and practical implementation.

4.2.2 Sweden Transport Optimization Analysis

To better highlight transport inefficiencies and consolidation opportunities in Sweden, a more detailed analysis has been conducted. First, it was identified the trucks that leave the central facility in Bjäre each day on fixed routes at fixed costs. There are 7 fixed routes that go through the country every day shown in Table 13 and Figure 13.

Table 13: Distribution Routes

Route	Cities
Route 1	Jönköping, Linköping, Norrköping
Route 2	Uppsala
Route 3	Södertälje, Årsta, Bromma
Route 4	Kristianstad
Route 5	Malmö, Lund, Helsingborg
Route 6	Södertälje
Route 7	Gothenburg

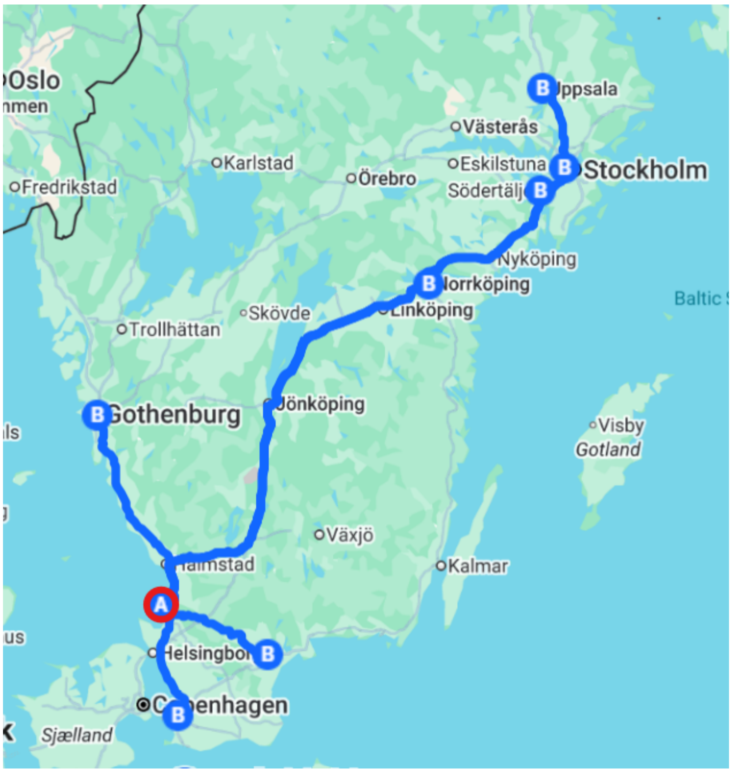


Figure 13: Map of fixed daily truck routes from the GC in Bjäre

To illustrate the methodology followed, it will be presented an example of the calculation for one route over two weeks. The same approach was applied to all routes across the 51-week period.

First, as shown in Table 14, the weekly chargeable weight was obtained by aggregating the chargeable weight of all shipments. Chargeable weight is defined as the maximum of the actual weight, the volumetric weight, and the loading meter equivalent, thereby accounting for both weight and space constraints. By comparing this with the maximum chargeable weight of the truck, the available weekly capacity could be estimated assuming one truck per day. A utilization level above 80% was considered to represent a full truck, meaning no additional capacity was assumed beyond this threshold.

Table 14: Example of capacity utilization for Route 1 during week 1 and 5

Route	**Week**	**Chargeable Weight**	**Fill Ratio**	**Capacity left**
Route 1	Week 1	70,975	39%	111,525
Route 1	Week 5	159,341	87%	0

On the other hand, the areas surrounding the destinations of the fixed routes have been analyzed in order to incorporate the transport in those zones into the fixed shipments if there's capacity left. In this way, products would be transported to the destination branch, where the warehouse acts as a hub, from which a shorter and more efficient last-mile delivery would be carried out. In Figure 14 it can be seen the different areas considered in Route 1.

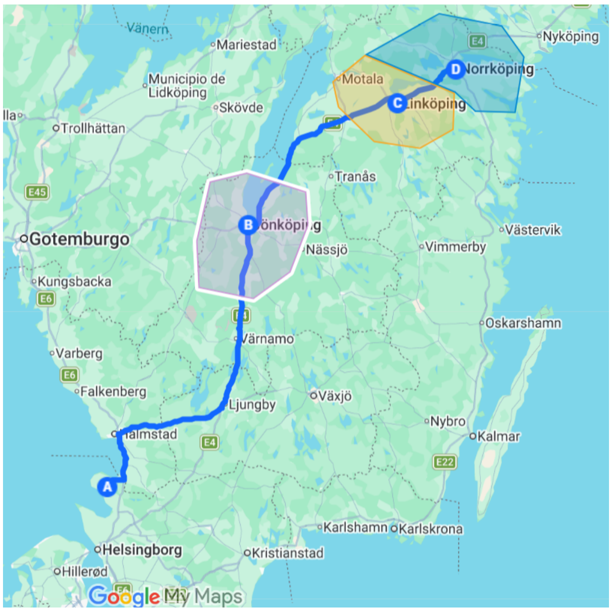


Figure 14: Areas near fixed Route 1 destinations

Therefore, transports from these areas are analyzed, as shown in Table 15, to assess whether they can be integrated into the available capacity of fixed-route trucks.

Table 15: Current direct shipment weights and costs for Route 1

Route	Week	Current Chg weight	Current cost (SEK)
1	1	10.180	5,121
1	5	13.664	7,021

As shown in Table 16, when there is available capacity, the transport cost of these deliveries is no longer considered. However, handling costs are added, as this requires an additional operation at the hub, as well as the cost of delivery from the central site to the branch and the last-mile delivery to the final customer. In addition, a cost is allocated for the use of the truck to the branch. Although this is based on a fixed transport cost, only half of the equivalent cost of the occupied capacity is considered, in order to account for the service provided and the consolidation effort. If no capacity is available, the cost remains the same as in the current situation, with direct delivery from the central site to the final customer.

Table 16: New cost structure for Route 1

Route	Week	New charged weight direct shipment	New cost direct shipment (SEK)	New cost handling + delivery (SEK)	New cost truck to branch (SEK)	Total cost (SEK)
1	1	0	0	1,218	1,639	2,857
1	5	13,664	7,021	0	0	7,021

Overall, taking into account the whole year with the 7 routes it was calculated the amount of deliveries that can be consolidated illustrated in Table 17.

Table 17: Comparison between current and future shipment distribution by route

	Current Situation	**Future Situation**	
	Nº Direct Shipments	**Nº Direct Shipments**	**Nº Shipments handled at branch**
Route 1	331	114	217
Route 2	186	0	186
Route 3	78	28	50
Route 4	223	38	185
Route 5	722	51	671
Route 6	260	0	260
Route 7	852	335	517
TOTAL	**2652**	**566**	**2086**

As can be observed, there are notable differences when transport is consolidated in Sweden. In addition, the savings associated with this reduction in direct deliveries have been calculated. The total savings across the seven routes amount to 25% per year, representing a substantial figure that reinforces the value of pursuing this initiative.

This calculation was carried out on a weekly basis, allowing for a more precise analysis and confirming that the potential savings identified are realistic. And in this regard, highligh that when the calculations are performed with more accuracy and more detailed operational data, the estimated savings are expected to be even higher, further strengthening the potential impact of transport consolidation.

4.3 Ongoing initiatives related to CT

Lindab's logistic network is currently being improved with a view to enhancing both visibility of product movement through its supply chain and cooperativeness throughout its supply chain. As part of this process, significant effort has been dedicated to the development of a CT PoC. This initiative was started after recognizing the challenges mentioned in the last section.
Since late 2024, the PoC has been developed and is still in progress in 2026. The primary use for the PoC is to facilitate the movement of goods from Bjäre to Lindab's various businesses, such as Lindab Sverige, Lindab UK and Lindab Norway. The PoC is showing considerable potential for the creation of value based on the results that have been achieved to date.

The findings from the PoC will be used in this thesis to assess the impact of the CT PoC within Lindab's supply chain more thoroughly.

4.3.1 Proof of Concept

The PoC serves as both a simplified model (though still realistic) of Lindab's logistics operations while providing a single planner, *interviewee D* , with tools needed to plan shipment movements. The PoC is designed with a defined workflow that incorporates information from both Power BI and the TM system to aid in the decision-making related to daily shipping activity.

The workflow starts two days prior to the planned departure of a shipment. At that time shipment quantities will be calculated using the CT Volume Planner in Power BI, and all shipments that are defined to be moving outwards will be characterized by their origin (from where they will be shipped), destination (to where they are being shipped), as well as volume, weight, and item detail.

From this output, the planner can identify whether there are other shipments going in the same direction that have similar characteristics, and evaluate wheter consolidating them into a single shipment. The goal of this process is to increase the total utilization of the trucks being utilized for the shipment, thereby eliminating partial load scenarios.

Consolidation opportunities are then validated using the TM system, which provides more detailed information related to each shipment (e.g., packaging type, quantity, picking area). This level of detail improves the accuracy of loading metre estimates and helps assess whether products can be physically combined, given constraints such as weight distribution and stackability. Different combinations are evaluated to determine whether consolidation is feasible or whether adjustments are needed.

Where adjustments are required, cross-functional coordination becomes essential. The PoC's responsible collaborates with stock controllers at the receiving locations to determine whether changes can be made to the quantity in question. If the quantity can be adjusted, Customer Service will update their orders accordingly. Once Customer Service has made the adjustment and adjusted quantities have been identified, the new shipment quantities will be reviewed before providing this information to the Transport Planner for final booking of the shipments in the TM system. All changes that have occurred due to the identified opportunities, and all associated savings, are documented in an Excel workbook for the purpose of tracking total PoC savings.

As noted by the responsible planner, *interviewee D*, the current process still relies heavily on manual intervention and expertise as *"the system does not fully document how items are packed or how items can be stacked, thus consolidation logic is based on experience".*

In its current form, the PoC covers only a small fraction of Lindab's logistics flows, managed by a single planner based in Grevie. It focuses on specific transportation flows between production facilities and branches where consolidation potential is greatest, and therefore represents a fraction of Lindab's total European logistics operations. This scope was deliberately kept narrow to allow for a controlled test of the concept before any broader rollout within the Lindab supply chain.

This limited scope also reflects a set of practical constraints inherent to the current setup. Certain physical product attributes relevant to consolidation, such as stackability and box dimensions, are not stored in the existing data systems, meaning the process depends entirely on the planner's operational judgement. The reliability and consistency of some datasets also remain limited, adding a further layer of manual validation to the planning process.

Despite these limitations, the PoC indicates how CT would operate on a larger scale where decisions would be supported automated by the capability of a better integration of data and improved system capabilities. A fully implemented CT across Lindab's European operations would leverage standardized and reliable data, better integrated systems, and more automation to substantially reduce manual intervention and further enhance potential operational and financial benefits.

Figure 15 summarises this workflow, illustrating the sequence of activities involved in the CT PoC and the interaction between the roles participating in the process. It shows how shipment data is first analysed in the CT Volume

Planner in Power BI to identify potential consolidation opportunities, which are then validated in the TM system before coordination takes place between the CT planner, stock controllers, customer service, and the transport planner for the final shipment booking.

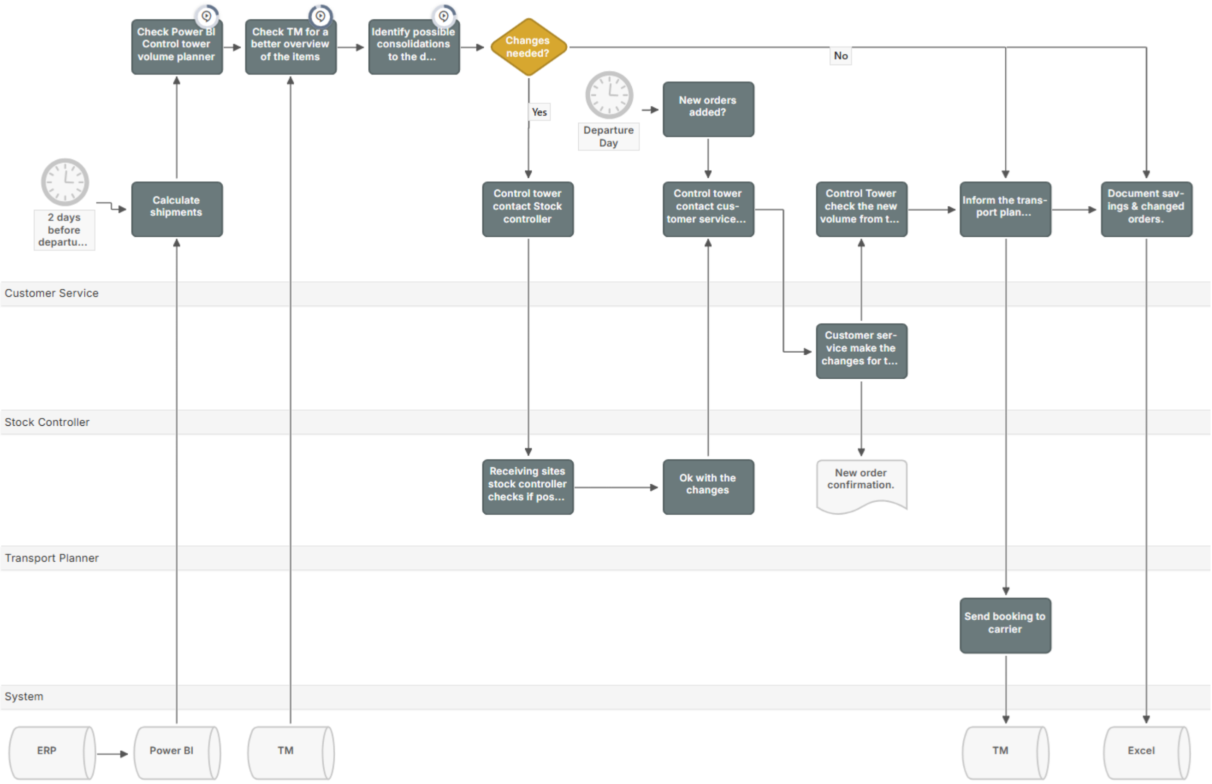


Figure 15: Workflow of the CT POC.

4.3.2 Savings with the POC

The CT PoC has been implemented across Sweden, Norway and the United Kingdom. However, the rollout did not start simultaneously in all countries. As shown in the Figure 16, Lindab began operating the PoC at a different point in time with each country.

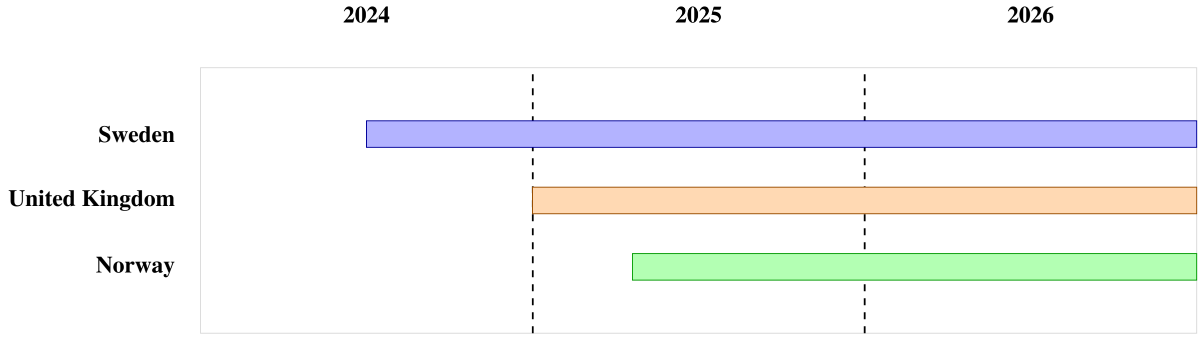


Figure 16: CT PoC timeline by country

Apart from not having started simultaneously, the results also began to be recorded during different time periods, and improvements have progressively been achieved over time. For these reasons, the analysis of the obtained results will only consider the data corresponding to 2026.

To present the benefits achieved, Table 20 shows the savings generated through the corrective actions enabled by the CT, which allow order consolidation and contribute to achieving a higher fill rate. It also includes the operational costs associated with the time dedicated to planning, coordination and analysis activities, estimated at 709 SEK per hour. Based on these values, the resulting benefit can be calculated. Since each country started operating the PoC at different weeks, an additional weekly benefit column has been included in order to enable a normalized comparison across countries.

Table 18: Benefits achieved during the CT PoC operational period

Country	**Total Savings (SEK)**	**Total Cost (SEK)**	**Total Benefit (SEK)**	**Avg. Weekly Savings (SEK)**	**Avg. Weekly Cost (SEK)**	**Avg. Weekly Benefit (SEK)**
Sweden	201,120	7,090	194,030	11,831	417	11,414
United Kingdom	152,327	21,979	130,348	10,880	1,570	9,311
Norway	220,295	28,183	154,532	12,239	1,566	8,585
TOTAL	**573,742**	**57,252**	**478,910**	**34,950**	**3,553**	**29,310**

The financial results presented in Table 18 provide an overview across the three countries included in the CT PoC. In every case, savings exceeded costs, producing a net positive outcome. Considering the average weekly benefit, it can be observed that the results are relatively similar across all three countries, indicating a consistent positive impact of the CT PoC. The data demonstrate that meaningful financial returns are achievable even under a largely manual setup with constrained resources. In order to provide a more visual comparison, the average weekly savings, benefits and costs are presented below in Figure 17 .

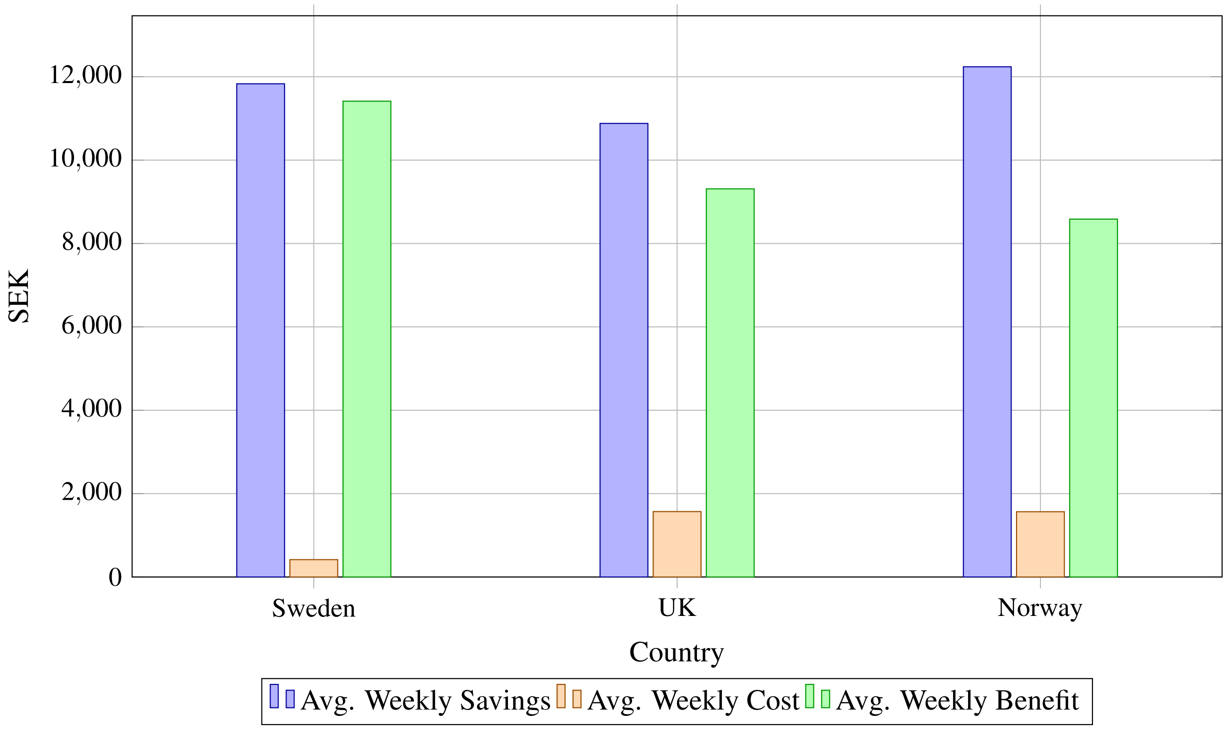


Figure 17: Average weekly savings, costs and benefits by country

Overall, the evidence gathered across the three countries makes a clear case for moving beyond the PoC. Clear benefits have already been observed despite the fact that the current setup is still highly manual. Therefore, the potential benefits could increase significantly if the initiative continues and the system becomes further automated.

It should also be noted that the comparison presented above is based only on the average results achieved in 2026, when the PoC was more consolidated. When considering the entire period since the PoC was launched (2024–2026), the accumulated savings amount to approximately **SEK 1.2 million**, highlighting the substantial value already generated by the initiative.

4.3.3 Comparison expected and real benefits

Once the expected benefits by country based on assumptions have been presented, and the benefits achieved through the PoC have also been analyzed, a comparison can be carried out in order to observe how close the estimated savings calculations are to the actual results obtained.

For this purpose, the weekly savings achieved in each country through the PoC presented in Chapter 4.3.1 have been taken as a reference and compared with the estimated benefits calculated for each country in Chapter 4.3.2.

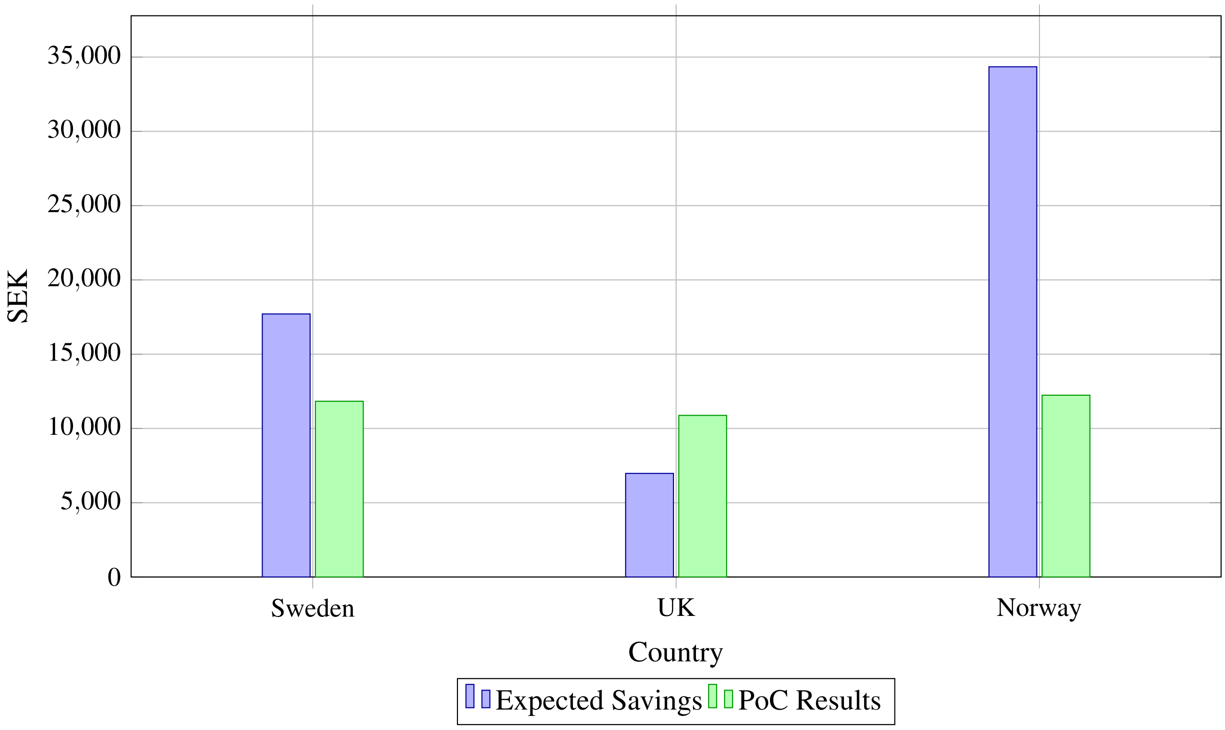


Figure 18: Comparison between expected savings and PoC results by country

Figure 18 shows that while the UK exceeded the expected savings, Norway and Sweden achieved lower results than initially estimated. Before drawing conclusions from this gap, an important clarification is needed: the expected benefits reflect the full potential of a complete CT rollout across all sites in each country, while the PoC covered only a fraction of that scope for now. In Sweden, the PoC was limited to Jönköping, Linköping, Norrköping (Route 1 to Södertälje) and in Norway, to Oslo, Bergen, Tromsö and Harstad. The UK reached a more advanced stage of implementation during the PoC period, which explains why its results aligned with the original estimate.

The underperformance of Sweden and Norway should therefore be read in that context. Norway, for instance, is one of the countries with the highest consolidation potential in the networkin terms of shipment volume. The gap between expected and achieved savings there does not reflect a problem with the CT concept, it simply shows how much potential remains untapped as long as the rollout stays partial. The UK result offers the clearest evidence of what happens when implementation reaches a more complete state, the actual savings closely matched what the quantitative model had projected.

Beyond scope, it is also worth noting that the PoC is being managed by a single person, without the automation and system integration that a mature CT would bring. Local companies are still adapting to a way of working that is entirely new to them, and some resistance to change remains. Under those conditions, the savings already achieved are more impressive than the numbers alone suggest, and there is a reasonable basis for expecting them to grow as both the scope and the operational maturity of the CT increase.

Overall, this comparison reinforces the case for continuing the implementation. The UK shows what is achievable when the CT operates closer to its full potential, and the gaps in Sweden and Norway point directly to where that potential still lies.

4.4 CT Implementation Challenges

In this part, it's outlined the main challenges associated with implementing the CT, highlighting the issues most frequently mentioned by the interviewees.

4.4.1 Local Resistance

One of the most frequently mentioned challenges among interviewees is resistance to change from local units, supported by a total of eight respondents. This represents a significant issue in the case of this company due to its decentralized organizational structure. As *Interviewee E* explains, when the company did not operate under such a decentralized structure, changes were implemented in a more mandatory way; however, today, if local units do not perceive clear benefits, they can resist adopting the change. The main concern, as *Interviewee K* notes, is that *"they are afraid that they will lose the local decision making, that it will be taken somewhere else centrally"*. This view is further supported by *Interviewee M*, who adds that each local site has strong knowledge of its own market conditions. As a result, shifting decision-making to a central level may lead to a lack of trust in the decisions being made, reducing motivation and creating potential "us vs. them" scenarios.

As a solution to this challenge, interviewees generally agreed that it is necessary for local units to understand the benefits of implementing the system. As *Interviewee H* states, it is important to *"get the units to accept it and see it as a project,"* and to achieve this, as *Interviewee L* explains, *"we need to show that it brings value"*. More specifically, Interviewee E suggests that one possible approach is to promote a mindset shift by highlighting that Lindab currently pays large sums to freight companies, whereas these resources could instead be retained within the company and redirected toward more valuable internal investments. In summary, stakeholders should be gradually informed about the initiative, as *Interviewee E* says *"informing people about goals, reasons, and benefits early,"* which may help increase understanding and support for this implementation.

4.4.2 Management Support

Another challenge mentioned by the interviewees is the potential misalignment among top management. In this regard, there are differences of opinion between various interviewees. On the one hand, several interviewees consider that it is not a problem at the management level, stating that *"many of the managers in the company are actually asking for this support to help them with logistics,"*. On the other hand, others do see a risk in this aspect. As *Interviewee M* points out, *"Most are aligned on piloting in southern Sweden but not on the long-term vision"* and acknowledging the importance as *Interviewee L* states *"management support is crucial and probably the biggest risk; if we as managers don't back this, it will fail."*

The main issue discussed is the importance each person assigns to this initiative; at a global level management understands that the growing operational complexity necessitates central oversight, but there may be different perspectives on it, especially because it clashes with the decentralized approach the company has followed so far. As *Interviewee N* notes, *"centralization initiatives may face skepticism among managers."*

However, in general, the approach that all interviewees agreed on, very similar to what was mentioned in the previous point, is *"to present a good business case with quantifiable benefits,"* as *Interviewee E* explains. This involves starting on a small scale in a region where the economic impact of the initiative is high and gradually showing results. In this way, the management team can understand the current need for implementation.

4.4.3 Data Quality

As mentioned in the previous section, data quality is a problem in the current logistics set-up, especially master data, and therefore it is also a challenge when implementing the CT. The main issue is that, as *Interviewee D* states, *"without reliable packaging and dimension data, full automation and network-wide coordination are difficult to implement."* Similarly, *Interviewee F* explains that *"without accurate data, analytics and forecasting are less reliable,"* highlighting how poor data quality affects not only transportation planning but also forecasting and replenishment decisions across the supply chain. As a consequence, as *Interviewee E* notes, *"poor data quality can undermine trust,"* which may also lead to a loss of support for the project if the expected level of visibility is not achieved.

Although data quality is a challenge, the interviewees agree that the data can still be trusted enough to start the implementation of the CT. As *Interviewee G* explains, *"to some extent the data can be trusted, but it is still a work in progress,"* and as data reliability increases, confidence in the implementation will also improve. However, as *Interviewee R* indicates, *"overall the data is not consistent enough across Lindab to fully support a CT implementation."* Therefore, while the implementation can begin, significant parallel work will be required to improve master data quality, standardize processes and data structures, and reduce manual dependencies across entities.

An additional external example related to data quality was highlighted by Interviewee B. The company previously attempted to outsource a CT to a 4PL, but after four months the initiative was stopped when it became clear that the data quality was not sufficient. As Interviewee B explained, "the learning from that for us was we need better master data and we need to tighten up our processes." This example illustrates that data quality represents a major risk in this type of implementation. Therefore, even though Lindab appears ready to implement the CT, it is important to carefully monitor data quality and continuously improve it throughout the implementation process.

4.4.4 System Integration

A similar situation as data quality exists regarding system integration. The current use of different systems, especially multiple ERPs, represents a challenge, as it significantly limits supply chain visibility. As *Interviewee G* explains, *""the main challenge comes from the existence of multiple ERP systems and the lack of standardized data structures across companies."* Therefore, this issue also affects the implementation of the CT. Futhermore, *Interviewee G* also explains, *"integration could be challenging because the systems store data in different ways, depending on the system used by each company."* As a result, this creates additional work in order to standardize the information and centralize it on a common platform. In this regard, and as mentioned previously, the company is currently carrying out a project to implement a common ERP system across the organization, which is expected to improve supply chain visibility and help the implementation of the CT.

4.4.5 Resources needed

Another risk identified in the interviews relates to the resources required for the implementation of the CT. Several interviewees emphasized that the project requires a dedicated organizational effort and sufficient human resources to ensure a successful implementation. As *Interviewee H* explained, *"for the CT, it's an organizational effort; first, Lindab needs to understand that it is worth hiring people and investing the effort."* Similarly, *Interviewee O* highlighted the importance of having a fixed team, stating that *"the main risk I foresee is having a team that is too small,"* explaining that if the team has fewer than three people, vacations or other absences could disrupt daily operations.

In addition to investments in dedicated personnel, several interviewees also highlighted the risks associated with technological resources. Future scalability is expected to depend on technological investments and process maturity. *Interviewee Q* stated that *“in the long term we need to work much more with machine learning and more advanced systems,”* while *Interviewee K* added that *“if you add AI, much of what it is done now could be handled by machinery in the future.”* Therefore, successful implementation will require continuous investment in systems, integration, and data management.

From a external point of view, *Interviewee C* points out *“if the company invests the necessary time and resources, ensures proper integration, and provides accurate master data, then the implementation can work smoothly.”* And emphasizes that *“as with any investment, a significant upfront cost is typically required before seeing a return on investment.”*

4.4.6 Organizational changes

Another risk closely related to local resistance and resource allocation concerns the organizational changes affecting the workforce, particularly at the local level. Due to the centralization of the system and the company’s traditionally decentralized structure, some functions may no longer be required locally. As *Interviewee K* explained, *“Today, each company has at least one person booking transport, one person purchasing internally, and maybe two or three people handling transport planning and buying to the warehouse.”* and added that *“I think there will be a significant reduction because this work can be centralized.”*

At the same time, *Interviewee N* supported this idea of a potential workforce reduction while emphasizing the transformation of job responsibilities, stating that *“The CT could reduce repetitive administrative tasks, allowing employees to focus on higher-value activities,”* leading to *“a shift toward more analytical and coordination functions.”*. However, *Interviewee E* points out that some operational activities will still require local personnel, since *“local shipments will still require people.”*

Consequently, the implementation of the CT is not only a technological transformation, but also an organizational change, requiring careful management of workforce transitions, role redefinition, and employee acceptance at the local level.

4.4.7 Summary of Finding

It is important to understand the level of importance that company employees assign to each barrier within the supply chain, as it indicates which challenges are perceived as the most critical for the successful implementation and development of the CT. To illustrate the frequency with which the different challenges were mentioned during the interviews, Figure 19 is presented.

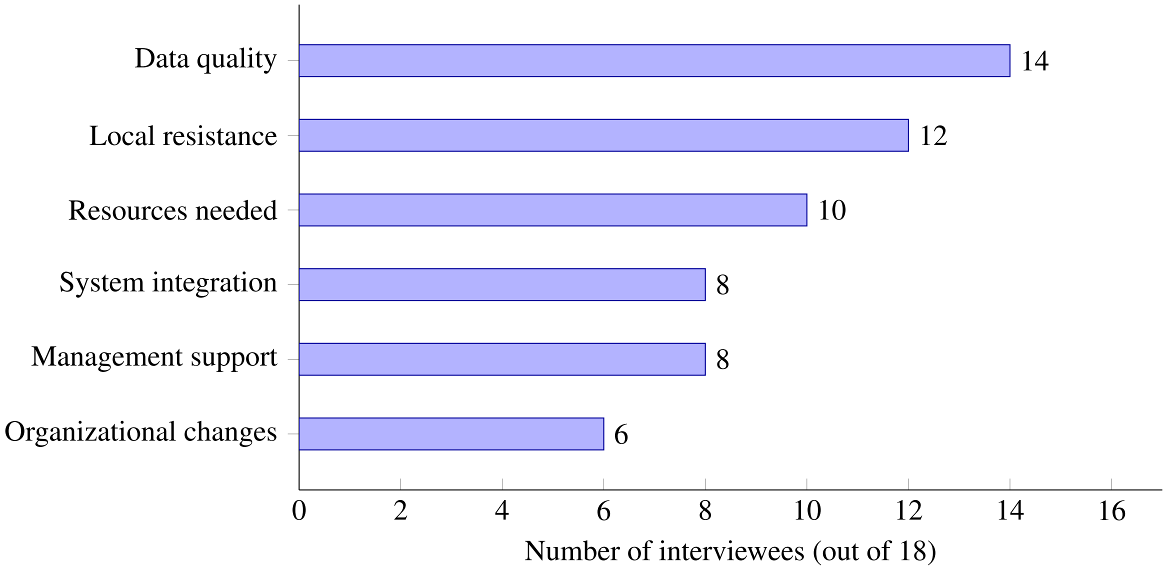


Figure 19: Frequency of implementation challenges mentioned by interviewees

4.5 Expected Benefits of the CT Implementation

During the interviews, stakeholders shared their expectations regarding what the CT should provide. They paid more attention to practical outcomes and less to technical aspects, focusing on the advantages that would make their tasks easier and enhance the efficiency of the supply chain. The following subsections outline the key benefits that emerged most consistently across roles and seniority levels.

4.5.1 Operational and Transport Efficiency

Operational efficiency and transport utilization were the two most frequently discussed benefits across interviews, and they are closely interrelated: better planning leads to higher truck fill rates, which in turn reduces unnecessary movements, frees up resources, and creates smoother operations across the network.

On the planning side, *Interviewee K* described how a CT allows for more optimal scheduling of truck arrivals to eliminate avoidable congestion at branches and make more effective use of available resources. *Interviewee M* further explained that an extended planning horizon and the ability to reshuffle deliveries can allow for simultaneous optimization of transportation and inventory *"without negatively impacting delivery performance." Interviewee L* added that improved coordination of orders across sites results in enhanced production and resource utilization, creating smoother operations overall. In line with this, *Interviewee Q* emphasized that centralizing replenishment could significantly improve production planning, noting that *"if we can handle replenishment from a central organization, that could create significant efficiency improvements in production. We could plan our production differently, so that would be a big help."*

Transport utilization is where these planning improvements translate most directly into measurable impact. All interviewees identified enhanced use of transport as a primary benefit, concentrating on maximizing truck capacity, eliminating excess truck miles, and reducing total transport costs. *Interviewee J* stated that *"improving the fill rate will ultimately result in freight cost savings,"* while *Interviewees D and E* estimated a potential 10–20% improvement in transportation efficiency through better planning. *Interviewee P* highlighted a clear opportunity to improve truck fill rates particularly in deliveries to branches, where significant untapped potential still exists, and noted that replacing manual planning with automated system calculations could further enhance accuracy. *Interviewee O* emphasized that maximizing truck utilization should be a key performance indicator, noting that increased average load levels can lead to substantially more efficient shipments, as already observed in some regions where trucks now consistently operate closer to full capacity.

Beyond transport, efficiency gains are also expected in administrative and warehousing processes. *Interviewee A* indicated that centralizing logistics departments can eliminate duplicate activities and reduce administrative costs by as much as 30%. *Interviewee N* cited process automation as a way to free up employees for higher-value tasks, and *Interviewee Q* pointed out that increased visibility and system integration would enhance administrative accuracy, reducing manual errors and unnecessary workload, as *"it takes a lot of administration and creates errors that could be avoided." Interviewee P* further anticipated that the system will streamline internal operations, noting that *"the benefits would include improved efficiency in production and warehousing,"* and that reducing peaks in production and warehouse activities would create more stable and efficient operations: *"if we can reduce peaks in production and in the warehouse, there is a lot of potential."*

Finally, reducing reliance on manual activity and creating a knowledge repository also contribute to long-term operational efficiency. *Interviewee J* expressed that by documenting transport rules and best practices in a system, teams can leverage existing knowledge regardless of employee turnover, creating consistency across operations. *Interviewee O* highlighted that the implementation of direct line hauls has already significantly reduced transit times in the North region, noting that *"after implementing direct routes, transit time has been reduced to about one week, improving operational efficiency and client satisfaction."*

4.5.2 Cost Reduction

Cost savings were consistently cited as one of the most tangible benefits of CT implementation, driven by three main levers: transport optimization, inventory management, and better use of commercial agreements.

On the transport side, *Interviewees J, M, and L* all emphasized the direct link between higher truck fill rates and lower freight costs. *Interviewee J* stated that *"by improving the fill rate, we will ultimately save on freight costs,"* while *Interviewee M* noted that cost reduction should not come at the expense of delivery performance. *Interviewee L* pointed out that better utilization leads to a lower cost per transported unit, and *Interviewee E* estimated savings of 10–20% through the elimination of unnecessary shipments. *Interviewee P* supports this view, noting that the main financial impact is expected to come from transport costs and overall logistics efficiency, particularly through improved coordination across sites.

Inventory management is the second significant source of cost reduction. *Interviewees K, N, M, and F* indicated that controlling stock levels more effectively could reduce working capital and obsolescence. As *Interviewee K* stated: *"Decreased costs due to obsolescence in our warehouses alone amounted to about 40 million SEK from EBIT last year."* The CT could help mitigate these costs by improving network-wide visibility of inventory levels and demand patterns, enabling earlier identification of slow-moving items and more proactive stock reallocation. *Interviewee Q* pointed out that improved inventory control can reduce fixed capital by as much as 20–30%, highlighting the financial impact of better stock management.

Finally, improved visibility and coordination enable smarter commercial decisions. *Interviewee B* noted that enforcing transport agreements allows the company to secure the best freight rates, while *Interviewee G* emphasized that a centralized overview of suppliers improves purchasing power and cost efficiency. As *Interviewee P* summarized, the financial case is largely driven by improvements in transport costs and inventory efficiency across sites, reinforcing the overall business value of the CT.

4.5.3 Inventory Visibility and Replenishment Coordination

A CT would make it significantly easier for Lindab to improve stock visibility and replenishment coordination, supporting lower excess stock levels, reduced working capital, and improved warehouse productivity. Several interviewees framed this as a shift towards a more centralized and transparent way of managing inventory across the network, where stock decisions are no longer made in isolation but from a broader system perspective.

Interviewees K, M, N, and F all emphasized that greater control of stock replenishment and placement is possible when all inventories are visible across sites. *Interviewee P* described the CT as a form of internal VMI, where *"we can centrally see all needs across the different warehouses,"* enabling more coordinated replenishment decisions and reducing the need for high local safety stocks. *Interviewee Q* emphasized the importance of having a central mandate and a helicopter view, allowing decisions about where and what to stock to be made from a system-wide perspective rather than at individual warehouse level.

One of the major areas affected is the reduction of slow-moving stock and tied-up capital. As *Interviewee F* noted, better inventory planning leads to *"less tied up capital … better cash flow,"* as well as more productive use of warehouse space. *Interviewee L* stated that *"a CT will promote the development of performance benchmarking and analysis of inventories across warehouses, which contributes to identifying slow-moving and overstocked items,"* while *Interviewee I* explained that centralized visibility allows for re-adjustments to control stock levels without impeding normal operations.

4.5.4 Service Levels and Flexibility

While Lindab already operates at a very high service level toward its end customers, *Interviewee K* noted *"close to 100% delivery accuracy"*, the focus of the CT is not to improve last-mile performance but to maintain it while building greater flexibility and reliability into the upstream network. As *Interviewee I* emphasized, *"the customer should not be aware of any changes we make to our service processes"* and *"the level of service must continue to be the same or better."*

Where the CT does contribute to service levels is in the coordination between internal sites. *Interviewee J* stated that after improving planning and coordination, *"the result may be that our customer will receive better service from the carrier because volumes will be more stable." Interviewee L* suggested that improved site coordination will result in improved reliability and smoother operations, and *Interviewee P* highlighted that the objective is to *"improve performance while maintaining a good delivery position."* Customer-facing visibility also plays a role: *Interviewee B* noted that *"customers are able to check on their shipments and status of their shipments without calling our customer service,"* reducing friction and improving the overall service experience.

Flexibility is closely related. Interview participants identified it as an important benefit, specifically referring to the system's ability to quickly accommodate spikes in demand, changes in routing, delays in production, and reductions in capacity. *Interviewee M* noted that extending the planning horizon allows deliveries to be rearranged to optimize fill rates without impacting service, while *Interviewee I* stated that through a CT, Lindab could have central visibility across its entire operation and make adjustments without disrupting local sites. *Interviewee A* added that a centralized structure for transportation means changes can be implemented much more quickly, as the company only needs to inform one area rather than all departments. As *Interviewee N* summarized, *"greater visibility leads to increased flexibility."*

4.5.5 Sustainability and Continuous Improvement

Sustainability and continuous improvement are two benefits that share a common logic: both are long-term outcomes that emerge from the same operational changes — fewer unnecessary transport movements, better data, and more stable processes.

On sustainability, the primary driver is shipment consolidation. Higher fill rates and fewer transport movements directly reduce CO2 emissions, and several interviewees were explicit about this link. As *Interviewee E* acknowledged: *"Cost savings are gained from reducing transport, without considering the CO2 reduction, because we gained higher fill rates." Interviewee P* reinforced this by noting that *"if we can achieve a higher fill rate for trucks, it would also be positive for sustainability,"* and *Interviewee D* stated simply that *"sustainability will improve as less transport is used."* Beyond transport, *Interviewee Q* pointed out that more efficient production batches reduce scrap and waste, and better inventory control limits the accumulation of obsolete products. *Interviewee C* added that access to emissions-related KPIs would allow Lindab to actively measure and reduce its CO2 footprint and demonstrate compliance to customers.

Continuous improvement is the natural extension of all the above. Once the CT is running and generating reliable data, the organization gains the ability to benchmark, iterate, and improve over time. *Interviewee I* described how a CT enables consistent tracking of KPIs such as employee transaction times and inventory movements, making it possible to identify inefficiencies and improvement opportunities systematically. *Interviewee J* highlighted the knowledge capture dimension: *"people leave the company and their knowledge leaves with them, so we want to store that knowledge somewhere and reuse it."* And *Interviewee O* perhaps put it most directly: *"it is important to never stop developing; new scopes can be added as they are identified,"* highlighting that the CT should be seen as a foundation that evolves over time rather than a fixed solution.

4.5.6 Summary of Benefits

The following Table 19 summarizes the key benefits identified across the 18 interviews conducted during the empirical analysis. For each benefit, the percentage of interviewees who raised it is indicated, alongside the KPIs through which Lindab could measure and track it in practice. It is worth noting that not all interviewees are explicitly cited in the previous sections, as quotes were selected for illustrative purposes rather than exhaustive representation of all responses.

Table 19: Summary of expected benefits identified through empirical analysis, citation frequency, and proposed KPIs for measurement.

Benefit	**Citation Frequency**	**KPIs**
Operational & Transport Efficiency	100%	Truck fill rate (%), transport cost per unit, number of consolidated shipments, administrative cost reduction, manual task elimination rate, lead time per site
Cost Reduction	100%	Total logistics cost, freight cost per shipment, inventory holding cost, working capital reduction
Inventory Visibility & Replenishment Coordination	76%	Inventory accuracy (%), slow-moving stock reduction, stock-out rate, working capital tied up in inventory

Benefit	**Citation Frequency**	**KPIs**
Sustainability & Continuous Improvement	65%	CO2 emissions per shipment, number of transport movements reduced, KPI trend over time, number of process improvements implemented, knowledge base growth
Service Levels & Flexibility	59%	On-time delivery rate (%), order fulfillment accuracy, response time to demand changes, number of rerouted shipments, planning horizon length

5 Results and Analysis

This chapter builds on the empirical evidence gathered through interviews and the PoC to examine what a CT implementation at Lindab would concretely require. It develops a conceptual model for Sweden, identifies the master data needed to support it, and assesses the broader viability of the initiative through a SWOT analysis, a Business Model Canvas and a customised version of the MAPE-K specifically for Lindab CT.

5.1 Opportunities and Challenges with the implementation of the CT at Lindab

In the literature review, an analysis was conducted on the barriers and benefits associated with the implementation of CTs in supply chains. On the other hand, information regarding the challenges and benefits identified by Lindab employees was collected through interviews. This section aims to establish a link between both perspectives in order to analyse similarities and identify aspects that may not yet have been considered, as well as others that may not apply to the case study.

5.1.1 Challenges

The barriers derived from the company's decentralized organizational structure become evident. Since each entity manages its logistics activities independently, this creates important limitations for the implementation of the CT.

Lindab's strong focus on the individual performance of each entity may increase *resistance to change*, as local units may find it difficult to perceive the collective and long-term benefits of the implementation. This issue is closely connected to the need for *fair sharing mechanisms*. The literature emphasizes the importance of establishing equitable mechanisms for distributing benefits and costs when collaborative systems are implemented across different companies or organizational units. Without such mechanisms, significant resistance may emerge at the local level. This becomes particularly relevant because decisions that are beneficial from a global perspective may negatively affect certain local entities, representing a major barrier in organizations where local units maintain a high degree of autonomy and decision-making power.

This *resistance to change* is also associated with the *technological transformation* itself. As highlighted in the interviews, many warehouse activities are still performed manually, meaning that the implementation of a system such as the CT may generate *innovation fatigue* among employees, particularly if the transformation is perceived as an additional burden rather than as an operational improvement. This demonstrates that the implementation of the CT is not only a technological transformation, but also a significant organizational and cultural change process.

In line with human factors, one barrier identified both in the literature and in the interviews is *top management resistance*, which can lead to delays in implementation and operational backlogs. This could represent a significant limitation in this case, since the system conflicts with the company's decentralized organizational structure. However, the interviews suggest that if the benefits are clearly demonstrated, as is currently being done through the PoC, top management is likely to support moving the project forward.

Another issue that should be highlighted, although it was not explicitly identified in the interviews, is the *skills and talent gap* required to support the implementation. Systems such as CTs require employees with problem-solving and complexity-management capabilities rather than purely technical skills. In this regard, Lindab currently has one employee leading the PoC at central level, and with almost 2 years of experience in this project. Therefore, to be able to have this capabilities in other employees either in the Regional CT in Czech Republic or at a local levle can be a challenge. Also job responsibilities would change and employees would require additional training to develop this new capabilities. Alternatively, external personnel with the necessary competencies may need to be hired.

Regarding the systems involved in the CT, *system integration* was identified as a major limitation. On the one hand, systems need to be suitable for a dynamic CT environment and, on the other hand, they must be capable of integrating effectively with one another. In this regard, the company's main current challenge is the implementation of the same ERP and TM systems across all Lindab entities, since companies that do not operate with these systems cannot be integrated into the Power BI platform used to manage the CT. Lindab is currently carrying out several projects aimed at achieving this standardization and integration across the organization. Therefore, standardization emerges as a prerequisite for achieving higher levels of visibility and automation.

Another major barrier discussed in both the literature and the interviews is *data quality*. It was identified by many interviewees as the main obstacle to the successful implementation of the system. In order to achieve a higher level of automation within the CT, it is necessary to address this issue and achieve internal alignment across different functional areas to effectively capture and manage the required data. In this regard, the literature also highlights the *lack of real-time information* and *limited information access* as important barriers. However, these challenges were not identified as significant issues in the case study, mainly due to the current availability and accessibility of data within the company.

One important challenge that was not fully addressed in the interviews is the *lack of standards and monitoring metrics* for managing the CT. This issue applies directly to Lindab, as the company was found to lack clearly defined metrics and KPIs to monitor performance, as well as standardized processes such as lead time management. Establishing standardized procedures and performance indicators would enable a more consistent way of operating across entities and, consequently, support a higher level of automation within the system. In addition, another related limitation concerns *insufficient policies and governance mechanisms*. For example, the company currently lacks penalties or accountability measures when performance metrics are not achieved, as well as mandatory procedures requiring employees to update the system once a delivery has been completed. These practices are not consistently implemented at present but would become necessary in the future to ensure data reliability, process standardization, and effective monitoring of the CT.

Finally, the last challenge identified by both the literature and the interviews concerns the *budget constraints* required for the implementation, particularly due to the technologies involved and their integration within the organization. However, as demonstrated in the PoC analysis, the potential savings are already tangible. Therefore, according to the interview findings, investing in the continuation and expansion of this initiative is not expected to represent a particularly difficult barrier to overcome.

Overall, this section provides an overview of the challenges identified in both the literature and the empirical findings. It is important to highlight that some barriers identified in the literature were not explicitly considered in the interviews and may therefore provide additional insights for the company when evaluating the future implementation of the CT.

5.1.2 Opportunities

To structure this section, the benefits will be divided according to the different areas of the supply chain. Therefore, the benefits identified in both the literature and the interviews will be discussed in order to provide an overview of the advantages that would apply to the Lindab case study.

The most central and extensively studied topic in this thesis is *transport optimization*, which is strongly supported by the literature. On the one hand, transport coordination contributes to greater *operational efficiency* by *increasing* *truck fill rates* and *reducing traveled distances*, which consequently translates into *cost benefits* and *higher service levels*. These advantages have already been demonstrated through the calculations presented in Section 4 and also strongly reflected in the interviews. Also, CT can *monitor delivery performance* against service level agreements (SLAs). This aspect is especially relevant for Lindab, as the company operates with varying transportation lead times, managing deliveries across multiple countries with significant differences in transport distances. However, it would require improvements in master data quality and the establishment of standardized planning rules to ensure accurate and consistent decision-making. In addition, *sustainability benefits* are also highlighted, as they were mentioned by a large number of interviewees.

Higher service levels are a benefit that needs to be interpreted carefully in Lindab's case. The interviews consistently pointed to the fact that Lindab already delivers a high service level to its end customers, which means the priority during implementation is not to improve it but to make sure it does not suffer in the process. However, there is genuine opportunity for improvement in the internal coordination between Lindab's own sites, Steel, GC, and RC, where greater visibility and better planning through the CT could meaningfully reduce delays and make internal flows more reliable. As for transportation mode selection, this is another benefit that does not really apply here: Lindab works almost exclusively with truck transport, and the routes where other modes like rail come into play are already well established and unlikely to change.

The second main topic is inventory management, as it was also heavily emphasized throughout the interviews. This strongly connects with the theoretical perspective regarding *inventory optimization*. On the one hand, a CT enables the *reduction of inventory levels* while simultaneously *preventing both overstock and understoc*k situations through real-time tracking of inventory across all locations and more *proactive decision-making*. This aspect aligns closely with Lindab's current inventory management structure, where each site manages inventory independently without a global overview of stock levels across the network. As a consequence, this decentralized approach can result in obsolete products occupying warehouse space, excessive inventory levels maintained to ensure high service levels, and a significant amount of tied-up capital. Through centralized *visibility* and *coordinated replenishment* decisions, the CT could enable Lindab to manage inventory from a network-wide perspective, improving stock allocation, reducing inefficiencies, and *optimizing working capital* across the organization.

The next area of the supply chain is manufacturing. CTs can improve *visibility of work-in-progress*, which contributes to enhanced *coordination and efficiency* across production plants. In addition, due to the centralization of data, CTs enable more *accurate demand planning and forecasting*, allowing organizations to achieve more efficient production processes while *avoiding unnecessary overproduction and excess inventory*. Lindab already operates with a highly efficient production system, characterized by structured daily planning and execution processes. However, improvements in replenishment coordination and inventory visibility could also positively impact production operations. More efficient replenishment processes would allow the company to produce larger and more optimized production batches, while increased *visibility across the supply chain* could enable earlier production planning and better *anticipation of future demand*. Consequently, this could further improve production efficiency while simultaneously supporting *higher service levels* across the network.

At a strategic level, the CT provides significant value to the company. On the one hand, greater control and visibility across the supply chain help the organization make more accurate and data-driven decisions regarding where to direct investments and prioritize operational improvements, while also providing additional financial resources derived from the cost benefits. This aligns with the theoretical benefits of *enable decisions to invest* and *better decision-making*. Likewise, this increased control over the supply chain is also related to the benefit of *continuous improvement*, widely mentioned both in the literature and during the interviews, since the CT enables the organization to identify inefficiencies, monitor network performance, and continuously improve the design of the SC. In addition, a benefit less emphasized in the interviews but highlighted in the literature is the *improvement of organizational models*, as the CT enables the connection of different silos within the company's supply chain, an aspect particularly relevant in Lindab's case due to its decentralized organizational structure, thereby facilitating better alignment between departments and a more integrated perspective for addressing strategic and tactical objectives across the organization.

5.1.3 Summary

To provide a structured overview of the opportunities and challenges identified throughout the study, a summary is presented in Table 20 and 20. The identified opportunities and challenges have been categorized according to whether they have already been considered by the company, are considered relevant but have not yet been addressed, or are not applicable within the Lindab context (because they are not relevant or because the company does not present these issues). However, some aspects could not be fully validated due to limited evidence or uncertainty regarding their practical realization within the Lindab context.

Table 20: Overview Challenges in the context of Lindab

Aspect	**Considered**	**Relevant but not considered**	**Not relevant**
CHALLENGES			
Local resistance to change	🟩		
Lack of fair benefit and cost sharing mechanisms between companies		🟨	
Resistance to technological transformation		🟨	
Innovation fatigue		🟨	
Top management resistance	🟩		
Skills and talent gap at central level			🟥
Skills and talent gap at local level		🟨	
System integration	🟩		
ERP and TM system standardization	🟩		
Master data quality	🟩		
Lack of real-time information			🟥
Limited information access			🟥
Lack of standards and monitoring metrics	🟩		
Insufficient policies and governance mechanisms	🟩		
Budget constraints		🟨	

Table 21: Overview Opportunities in the context of Lindab

	Aspect	Considered	Relevant but not considered	Not relevant
OPPORTUNITIES				
TRANSPORTATION	Transport cost reduction	🟩		
	Truck fill rate improvement	🟩		
	Reduction of travelled distances	🟩		
	Delivery performance monitoring		🟨	
	Transport lead time coordination		🟨	
	Sustainability benefits	🟩		
	Higher service level improvement			🟥
	Transport mode selection			🟥
INVENTORY	Inventory level reduction	🟩		
	Prevention of overstock and understock	🟩		
	Network-wide stock visibility	🟩		
	Reduction of obsolete inventory	🟩		
	Working capital optimization	🟩		
PRODUCTION	Work-in-progress visibility		🟨	
	Demand planning and forecasting improvement	🟩		
	Production batch optimization		🟨	
	Earlier production planning	🟩		
STRATEGIC	Better decision-making	🟩		
	Investment prioritization	🟩		
	Continuous improvement	🟩		
	Improvement of organizational models		🟨	

5.2 Lindab Requirements for Implementation

As observed in the challenges of implementing a CT, this system represents a challenge on multiple levels, particularly regarding data quality, system integration, and organizational change. Before the system can be expanded and reach its full potential, Lindab must meet a series of fundamental requirements covering different dimensions: the quality and availability of the data on which the CT will depend, the standardization of systems and processes, and the ability to manage organizational changes effectively.

5.2.1 Requirements of Master Data

Implementing a CT is not just a technological decision, it depends equally on the quality and availability of the data that feeds it. A CT can only monitor, analyze, and respond effectively if the underlying master data is accurate, complete, and consistently structured across all systems. In Lindab's case, this is particularly relevant given the fragmented IT landscape and multiple systems identified in Chapter 4.1 Current Logistics Challenges at Lindab, which create significant risks of data inconsistency and duplication.

To make this actionable, the required master data has been organized by the key functional departments responsible for its management and use. This approach clarifies data ownership, facilitates governance, and accelerates implementation by linking each data type to the department that primarily uses it. Following the identification of each data requirement, subsequent meetings with Lindab were held to assess the current availability and quality of each data element, the results of which are reflected in the tables below.

Warehouse / Inventory Management
Warehouse and inventory data forms the operational backbone of the CT's monitoring capability. Without accurate, real-time visibility of stock levels, locations, and replenishment parameters across all sites, the CT cannot detect imbalances, anticipate shortages, or coordinate replenishment effectively.

Table 22: Master data requirements — Warehouse / Inventory Management

Data Element	**Description**	**Avail.**	**Quality**
Product Identification			
Product ID	Unique identifier consistently used across all systems and entities	Available	Good
SKU	Identifier for sellable or logistical variants	Available	Good
Product category	Functional classification (e.g., duct, elbow, grille, damper, accessory)	Available	Not as Good
Product family / group	Grouping based on design or usage similarities	Available	Not as Good
Standard unit of measure	Default unit for transactions (piece, meter, set)	Available	Not as Good
Packaging unit	Defines packaging and storage format (pallet, box, bundle)	Available	Not as Good
Weight	Product weight for logistics calculations	Available	Bad

Data Element	**Description**	**Avail.**	**Quality**
Volume	Product volume for storage and transport planning	Available	Bad
Handling type	Defines warehouse handling logic (palletized, small box, batch picking)	Available	Bad
Inventory Levels			
Warehouse ID	Identifier of the warehouse	Available	Good
Storage location	Exact physical position of inventory (bin/rack)	Available if WMS used	Bad
Quantity on hand	Physical stock available	Available	Not as Good
Booked inventory	Stock allocated to confirmed customer orders	Available	Not as Good
Inventory in transit	Stock shipped but not yet received	Available	Good
Timestamp of last update	Data freshness indicator	Available	Good
Replenishment and Service Management			
Reorder point	Inventory threshold triggering replenishment	Available	Not as Good
Reorder quantity	Quantity ordered when replenishment is triggered	Available	Not as Good
Order frequency	Frequency of replenishment cycles	Available	Bad
Agreed lead time	Expected replenishment time from suppliers or internal production	Available	Not as Good
Minimum order quantity	Supplier-imposed constraint	Available	Not as Good
Service level target	Target probability of meeting demand without stockout	Available	Not as Good
Availability KPI	Measure of product availability to fulfill demand	Available	Not as Good
Risk buffer parameters	Buffers used to mitigate uncertainty in demand and supply	Available	Not as Good
Regulatory and Product Constraints			
Certification type	Required product certifications (CE, ISO, air quality standards)	Not available	-
Certification issue date	Start of certification validity	Not available	-

Data Element	Description	Avail.	Quality
Certification expiry date	End of certification validity	Not available	-
Country-specific regulation	Legal requirements depending on market	Not available	-
Application-specific regulation	Usage-dependent constraints (hospital, commercial building)	Not available	-
Air quality compliance level	Performance requirements for ventilation products	Not available	-

The Warehouse and Inventory Management block has a functional foundation: identifiers, real-time inventory levels, and transit tracking are all solid. The real issue is quality in the physical attributes, as weight, volume, and handling type exist in the system but are frequently wrong or managed by experience rather than captured as structured data, which directly limits the CT's ability to calculate load configurations and consolidation potential. Replenishment parameters are available but inconsistently maintained, service level targets live outside the ERP, and certification data exists somewhere in surrounding databases but its accessibility remains unclear. The CT can operate with what is there today, but improving physical and replenishment data quality should be treated as a parallel workstream from the start.

Production / Manufacturing

Production data is essential for the CT to understand supply-side constraints and coordinate internal flows. Accurate bills of materials, production lead times, and capacity data allow the CT to anticipate bottlenecks and align production schedules with logistics planning.

Table 23: Master data requirements — Production / Manufacturing

Data Element	Description	Avail.	Quality
Sourced Materials (Procurement Data)			
Material ID	Identifier of purchased material	Available	Good
Supplier ID	Supplier providing the material	Available	Good
Minimum order quantity	Supplier constraint	Available	Bad
Agreed lead time	Expected delivery time	Available	Not as Good
Lead time variability	Variation in delivery time	Not available	-
Transport lead time	Time from supplier to production facility	Available	Not as Good
Supplier reliability	Unknown	Not available	-

Data Element	Description	Avail.	Quality
Incoterms	Responsibility and risk allocation in transport	Not available	-
Production Data (Internally Produced Items)			
Semi-finished product ID	Identifier of intermediate products used in production	Available	Good
Production lead time	Time to transform materials into semi-finished or finished goods	Available	Bad
Machine capacity	Available capacity of production equipment	Available	Bad
Labor capacity	Available workforce capacity	Available	Bad
Production constraints	Restrictions affecting production flow (bottlenecks, scheduling limits)	Available	Bad
Bill of Materials (BOM)			
Finished product ID	Identifier of the final product	Available	Good
BOM version	Version of the BOM	Available	Good
Component ID	Components required for production	Available	Good
Component quantity	Quantity per finished product	Available	Good
BOM validity period	Time range in which the BOM is applicable	Available	Good
Alternative BOM identifier	Identifier for different BOMs producing the same finished product	Not available	-
BOM selection parameter	Rule or parameter used to select the appropriate BOM	Available	Not as Good

The BOM block is the strongest in this section, with clear and reliable master data connecting raw materials, semi-finished products, and finished goods. Procurement identifiers are equally solid. The critical weakness lies in production data: lead times, machine capacity, labor capacity, and constraints all exist in the ERP but are not trusted in practice, with planners working instead from local Excel files and their own tools. This means the CT cannot rely on ERP production data for real-time decisions without a parallel effort to bring that planning back into the system. Lead time variability, supplier reliability, and Incoterms are either unavailable or managed outside the ERP entirely, representing gaps that will need attention as the CT scope expands beyond transport consolidation.

Business Priorities

Defining business priorities ensures that the CT makes decisions aligned with Lindab's strategic objectives. Without a clear order priority framework, the system cannot distinguish between critical and standard shipments when resolving exceptions or allocating resources.

Table 24: Master data requirements — Business Priorities

Data Element	Description	Avail.	Quality
Business Priorities			
Order priority level	Priority assigned to an order to determine its handling order in logistics execution	Available	Good

Lindab already follows a clear operational priority logic, where customer deliveries are treated as more critical than stock replenishment. This prioritization is consistently applied across order handling, production planning, and inventory management, showing that the company already has usable and reliable priority data. For a future CT this is valuable because it allows the system to make faster and more aligned decisions when managing exceptions, allocating resources, or responding to disruptions.

Transportation / Logistics

Transportation data is the core operational input for the CT. Without reliable carrier profiles, shipment data, and physical characteristics, the CT cannot plan consolidations, optimize routes, or monitor flows across the network.

Table 25: Master data requirements — Transportation / Logistics

Data Element	Description	Avail.	Quality
Carrier & Supplier Profiles			
Supplier ID	Unique identifier of a carrier and supplier in the system	Available	Good
Supplier name	Official name of the carrier and supplier	Available	Good
Transport service type	Type of transport service provided by the carrier (FTL, LTL, parcel)	Not available	-
Regions served	Geographical areas covered by the carrier and supplier	Available if WMS used	Good
Fleet characteristics	Operational attributes of transport fleet (capacity, vehicle type, constraints)	Not available	-
Performance indicators	Metrics measuring supplier or carrier performance over time (on-time delivery, reliability)	Available if TMS used	Good
Contract validity period	Time period during which the contract with supplier or carrier is active	Not available	-
Geographical Locations			
Location ID	Unique identifier of a physical location in the network	Available	Good

Data Element	Description	Avail.	Quality
Location name	Human-readable name of the location (e.g., factory, warehouse name)	Available	Good
Location type	Classification of the role of the location in the supply chain network	Available	Not as Good
Address	Physical street address of the location	Available	Good
Geographic coordinates	Precise spatial coordinates of a location used for route optimization	Available	Good
Country and region	Country and region where the location operates	Available	Good
Time zone	Time zone in which the location operates	Available	Good
Operating hours	Time intervals during which a location is operational	Available	Good
Translation Tables			
Source system ID	Identifier of the originating system where the data is generated	Not available	-
Target system ID	Identifier of the system where data is mapped or consumed	Not available	-
Source data code	Original identifier used in the source system	Not available	-
Target data code	Mapped identifier used in the destination system	Not available	-
Data object type	Type of business entity being mapped across systems (product, supplier, location)	Not available	-
Type of Cargo			
Pallet name	Unique identifier for a cargo classification type	Available	Not as Good
Product category mapping	Link between product categories and their corresponding cargo types	Not available	-
Handling requirements	Special conditions required for storing or transporting the product	Not available	-
Hazard classification	Classification indicating whether a product is hazardous and its risk level	Not available	-
Fragility classification	Indicates if a product is sensitive to damage during transport	Available	Good
Stackability classification	Defines whether and how products can be stacked during transport or storage	Not available	-

Data Element	Description	Avail.	Quality
Packaging requirements	Rules defining how a product must be packaged for transport or storage	Not available	-
Palletization configuration	Definition of how products are arranged on pallets	Not available	-
Physical Characteristics			
Net weight	Weight of the product without packaging	Not for all	Good
Gross weight	Total weight of product including packaging	Not for all	Not as Good
Length	Product length for transport and storage planning	Not for all	Good
Width	Product width for transport and storage planning	Not for all	Good
Height	Product height for transport and storage planning	Not for all	Good
Volume	Product volume for transport and storage planning	Not for all	Good
Transport Mode for Product Delivery			
Product or product group	Identifier of the product or group to which transport rules apply	Not available	-
Preferred transport mode	Default or optimal transport method for a product (truck, parcel, pallet)	Not available	-
Alternative transport modes	Other acceptable transport options if the preferred mode is unavailable	Not available	-
Mode restrictions	Constraints that prevent certain transport modes for specific products	Not available	-
Standard transit time	Expected duration of transport under normal conditions	Not available	-
Estimated transport cost	Expected cost associated with each transport mode	Not for all	Not as Good
Impact and possible delays	Expected disruptions or delays associated with each transport mode	Not available	-
Sensitivity of transport modes	Sensitivity level of each transport mode to disruptions	Not available	-
Carbon emission factor	Estimated environmental impact of transport mode	Available yearly	Good
TMS			
Shipment ID	Unique identifier of a physical shipment	Available	Good
Pickup location	Origin location where goods are collected	Available	Good

Data Element	**Description**	**Avail.**	**Quality**
Loading sequence	Order of loading	Available if TMS used	Not as Good
Delivery location	Origin and destination location where goods are delivered	Available	Good
Planned departure time	Scheduled time for shipment departure	Available if TMS used	Not as Good
Planned arrival time	Expected time of delivery	Available if TMS used	Not as Good
Bill of lading number	Legal transport document identifier for the shipment	Available	Not as Good
Delivery confirmation status	Status indicating whether the shipment has been delivered	Available if TMS used	Good
Transport cost	Cost associated with executing the shipment	Not for all	Not as Good
Lane Capacities			
Transport mode	Type of transport used on the route (LTL: several customers, FTL: one customer)	Available	Good
Assigned carrier	Default transport provider responsible for the route	Available	Good
Standard transit time	Expected travel time between origin and destination	Available	Good
Real time route optimization	Real time data optimization of the routes	Available	Good
Weather Events			
Location	Location affected by the weather event	Not available	-
Weather event type	Type of meteorological event	Not available	-
Event severity	Severity level of the weather event	Not available	-
Start time	Start time of the weather event	Not available	-

Data Element	Description	Avail.	Quality
End time	End time of the weather event	Not available	-
Expected logistics impact	Expected disruption to logistics operations	Not available	-
Traffic Intensities & Road Status			
Road segment ID	Identifier of the road segment	Available	Good
Traffic congestion level	Current level of traffic congestion	Available	Good
Average travel speed	Average speed on the road segment	Available	Good
Road closure status	Whether the road segment is closed or open	Available	Good
Incident reports	Reports of incidents affecting traffic flow	Available	Good
Alternative route availability	Availability of alternative routes in case of disruption	Available	Good
Labor Strikes / Holidays			
Country or region	Country or region affected by the event	Not available	-
Specific logistics laws	Logistics regulations specific to each country	Not available	-
Event type	Type of event affecting logistics (strike, public holiday)	Not available	-
Start date	Start date of the event	Not available	-
End date	End date of the event	Not available	-
Impacted sectors	Sectors affected by the event	Not available	-
Expected disruption level	Expected level of disruption to logistics operations	Not available	-

The Transportation block presents a solid foundation to build on. Core data such as carrier profiles, geographical locations, lane capacities, and real-time traffic information via Google Maps is already available and reliable. TMS data covers the essentials, though availability depends on whether individual sites have adopted the system, which varies across the network. The most significant gaps are in cargo and physical characteristics: stackability, palletization, packaging requirements, and handling rules exist only in the heads of experienced planners and have never been captured as structured data, which directly limits the CT's ability to automate consolidation decisions. Physical dimensions are incomplete across several product families, particularly for Steel products. Translation tables represent a structural gap that will need to be built from scratch: as confirmed internally, even companies sharing the same ERP can have misaligned item codes imported from legacy systems, making a common mapping key essential for the CT to produce a reliable picture across entities. Weather and labor strike data are not available and are not considered a priority at this stage.

IT / Data Governance

Data governance defines who owns, maintains, and can access each data element within the CT. Without clear ownership rules and access controls, data quality deteriorates over time and the system loses reliability. This is particularly critical in Lindab's case, given the number of systems and countries involved.

Table 26: Master data requirements — IT / Data Governance

Data Element	Description	Avail.	Quality
Access Rights & Ownership Rules			
Data object type	Category of data being governed (product, location, supplier, etc.)	Available	Good
Data owner department	Department responsible for the accuracy and integrity of a data object	Available	Good
Data steward	Person or role responsible for maintaining data quality and consistency	Available	Good
User role definitions	Definition of roles that determine how users interact with data	Available	Good
Read/write permissions	Rules defining who can view or modify specific data	Available	Good
System access rights	Technical permissions defining system-level access to data sources	Available	Good
Data update frequency	How often data is updated or refreshed in the system	Available	Good
Data validation rules	Rules ensuring that data entered into the system is correct and consistent	Available	Good
Audit trail records	Historical log of all changes made to data	Available	Good

The IT and Data Governance block is the strongest of all master data categories assessed. Access rights, ownership rules, data stewardship, and audit trails are all centrally managed through Identity and Access Management (IAM) and connected systems, with consistent availability and reliable quality across business units. This is not a given in organizations of Lindab's scale and decentralization: having formal governance structures already in place means the CT will not need to build this foundation from scratch. The main risk going forward is not availability but consistency of enforcement: quality in this block depends heavily on whether roles are actively maintained, reviews are conducted regularly, and joiner-mover-leaver processes are followed. As long as those practices remain disciplined, this block poses no significant obstacle to CT implementation.

5.2.2 Requirements of System Integration

The CT implementation is closely linked to the use of a common ERP system, Microsoft Dynamics 365 (D365), across the company. As identified in Chapter 4.4.4, one of the main challenges for CT implementation was system integration. In order for a site or country to be included in the project, it is necessary to operate under the same ERP environment. For this reason, Lindab is currently carrying out a company-wide ERP harmonization project shifting to D365.

However, the ERP system used across most parts of the company is currently AX 4.0, which is still suitable for carrying out the CT implementation. The following Table 27 presents the current ERP situation in each country, and it is ordered as the implementation is going to follow, between 2026-2029. As can be observed, the countries that do not currently use either D365 or AX 4.0 are not yet prepared to implement the CT.

Table 27: Overview of rollout and ERP situation by country

Country	Type	Ready for CT?	ERP
FR	Regional	YES	D365
EE	Regional	NO	Other
FI	Regional	NO	Other
DE	Regional	NO	Other
CZ	Regional	YES	AX 4.0
CZ	Central - Karlovaska	YES	AX 4.0
PL	Regional	NO	Other
NL	Regional	NO	Other
UK	Regional	YES	AX 4.0
HU	Regional	NO	Other
CH	Regional	YES	AX 4.0
IE	Regional	NO	Other
SE	Regional	YES	AX 4.0
SE	Central - Bjäre	YES	AX 4.0
DK	Regional	YES	AX 4.0
NO	Regional	YES	AX 4.0
IT	Regional	YES	AX 4.0

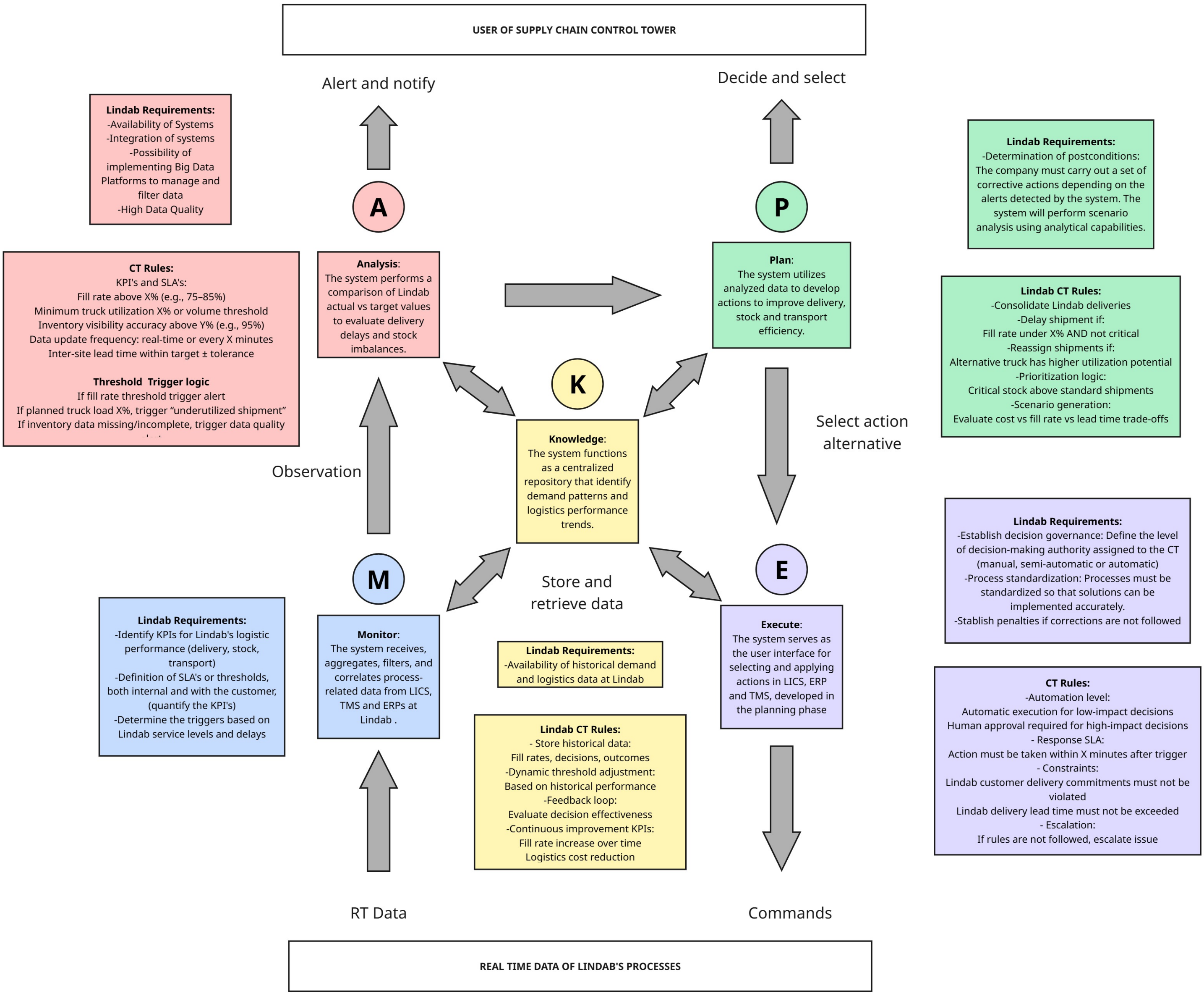
Therefore, the main requirement from a systems integration perspective is that the entities share the same ERP as the Central CT to be able to be integrated in this CT and also to be able to carry out the Regional CT within the same country. Consequently, for the countries that do not yet meet this requirement, the planned implementation dates of D365 will indicate the earliest possible dates for CT implementation.

5.2.3 Requirements of MAPE-K Process

Section 3.7 established the MAPE-K loop as the theoretical backbone of a CT's functionality. Applying it to a real organization, however, requires grounding each phase in concrete operational needs. In Lindab's case, these needs emerge from the logistics inefficiencies and transport utilization gaps identified through the empirical analysis, as well as the experience gained from the PoC.

This section defines the requirements of each phase from two angles: what the CT must be capable of doing (monitoring, interpreting deviations, generating responses, and learning over time) and what Lindab must provide to make that possible, from data sources and system integrations to organizational inputs and decision governance.

Figure 20 illustrates the proposed MAPE-K design for Lindab's CT. Each phase is mapped against three elements: the functional requirements the CT must fulfill, the inputs Lindab must provide, and the operational rules that govern when and how the system responds.



Lindab Requirements:
-Availability of Systems
-Integration of systems
-Possibility of implementing Big Data Platforms to manage and filter data
-High Data Quality

CT Rules:
KPI's and SLA's:
Fill rate above X% (e.g., 75–85%)
Minimum truck utilization X% or volume threshold
Inventory visibility accuracy above Y% (e.g., 95%)
Data update frequency: real-time or every X minutes
Inter-site lead time within target ± tolerance

Threshold Trigger logic
If fill rate threshold trigger alert
If planned truck load X%, trigger "underutilized shipment"
If inventory data missing/incomplete, trigger data quality

Analysis: The system performs a comparison of Lindab actual vs target values to evaluate delivery delays and stock imbalances.

Plan: The system utilizes analyzed data to develop actions to improve delivery, stock and transport efficiency.

Lindab Requirements:
-Determination of postconditions: The company must carry out a set of corrective actions depending on the alerts detected by the system. The system will perform scenario analysis using analytical capabilities.

Lindab CT Rules:
-Consolidate Lindab deliveries
-Delay shipment if:
Fill rate under X% AND not critical
-Reassign shipments if:
Alternative truck has higher utilization potential
-Prioritization logic:
Critical stock above standard shipments
-Scenario generation:
Evaluate cost vs fill rate vs lead time trade-offs

Knowledge: The system functions as a centralized repository that identify demand patterns and logistics performance trends.

Lindab Requirements:
-Establish decision governance: Define the level of decision-making authority assigned to the CT (manual, semi-automatic or automatic)
-Process standardization: Processes must be standardized so that solutions can be implemented accurately.
-Stablish penalties if corrections are not followed

Lindab Requirements:
-Identify KPIs for Lindab's logistic performance (delivery, stock, transport)
-Definition of SLA's or thresholds, both internal and with the customer, (quantify the KPI's)
-Determine the triggers based on Lindab service levels and delays

Monitor: The system receives, aggregates, filters, and correlates process-related data from LICS, TMS and ERPs at Lindab .

Lindab Requirements:
-Availability of historical demand and logistics data at Lindab

Execute: The system serves as the user interface for selecting and applying actions in LICS, ERP and TMS, developed in the planning phase

CT Rules:
-Automation level:
Automatic execution for low-impact decisions
Human approval required for high-impact decisions
- Response SLA:
Action must be taken within X minutes after trigger
- Constraints:
Lindab customer delivery commitments must not be violated
Lindab delivery lead time must not be exceeded
- Escalation:
If rules are not followed, escalate issue

Lindab CT Rules:
- Store historical data:
Fill rates, decisions, outcomes
-Dynamic threshold adjustment:
Based on historical performance
-Feedback loop:
Evaluate decision effectiveness
-Continuous improvement KPIs:
Fill rate increase over time
Logistics cost reduction

Figure 20: MAPE-K framework applied to Lindab's Supply Chain CT

As shown in Figure 20, the **Monitor** phase requires Lindab to identify and quantify the KPIs that reflect its logistics performance (fill rate, truck utilization, and inter-site lead times) and to establish SLA thresholds for both external customers and internal Lindab sites that operate as receiving entities within the network. Beyond thresholds, this phase also requires defining the triggers that activate the loop, based on Lindab's own service levels and delay patterns. All of this is fed by real-time data flowing from Lindab's core systems IMS, TMS, and ERPs, which serve as the primary data sources for the CT.

These inputs feed directly into the **Analysis** phase, where the CT compares real-time data from Lindab's systems against those targets. Here, specific threshold logic governs when the system escalates: a fill rate below the defined threshold triggers a consolidation alert, a planned truck load below capacity flags an underutilized shipment, and incomplete or missing inventory data, activates a data quality alert.

When a deviation is detected, the **Planning** phase determines the corrective action. The CT evaluates available alternatives through scenario analysis comparing cost, fill rate, and lead time trade-offs. To make this operational, Lindab must define upfront the rules that govern each situation: consolidating or delaying non-critical shipments with low fill rates, reassigning loads when a better-utilized truck is available, and prioritizing critical stock over standard shipments. These rules must also align with the transport consolidation logic already in Lindab's ERP, where orders sharing the same customer account, ship date, delivery address, and delivery mode can be grouped into a single transport.

The selected action then moves to **Execution**, but for the CT to act reliably, Lindab needs to lay some groundwork first. Processes must be standardized so that corrections can be applied consistently across the network, decision-making authority must be clearly defined (what the CT handles automatically, what needs a human in the loop, and what stays fully manual), and there need to be consequences when defined corrections are not followed. Once that governance is in place, the CT operates within a clear set of boundaries. Low-impact decisions run on their own; anything high-stakes waits for human approval. Every action has a response window, and two rules are non-negotiable: customer delivery commitments cannot be touched, and Lindab's delivery lead times cannot be exceeded. If those lines are crossed, the issue escalates.

Underpinning the entire loop is the **Knowledge** base: the part of the system that turns experience into intelligence. For this to work, Lindab must ensure that historical demand and logistics data is available and accessible to the CT. From there, the rules are straightforward but powerful: the system stores fill rates, past decisions, and their outcomes. Uses that history to dynamically adjust thresholds as operational patterns evolve and continuously evaluates whether the actions taken are actually working. Over time, this feedback loop is what drives real improvement , not just in fill rate and logistics cost, but in the CT's ability to make better decisions with every cycle. For Lindab, this is particularly relevant given the savings already demonstrated by the manual pilot, a structured feedback loop is what transforms those isolated gains into systematic and scalable improvement.

5.3 Requirements organizational challenge

As already established in Section 3.6.1, the greatest risks to a successful CT implementation are not technical, they are human. With 90% of implementation problems rooted in processes and people (Freichel et al., 2022), and failure rates for CT initiatives reaching 50% (Vlachos, 2021a), a structured approach to managing organizational change is a prerequisite. Building on the challenges and opportunities identified in Chapter 5.1, the following section applies Kotter's eight-step model (Kotter, 1996) to Lindab's specific context, providing a concrete roadmap for navigating this transition.

- *Step 1 — Establish a Sense of Urgency*: The foundation for urgency already exists. The persistent transport utilization inefficiencies, data quality gaps, and decentralized coordination failures documented in Chapter 4.1 Current Logistics Challenges at Lindab represent a clear cost of inaction. Also, the PoC has already quantified what change looks like: 1,3 MSEK in total savings across the pilot countries since its implementation, as detailed in Chapter 4.3.2. Leadership should use these figures actively (not buried in internal reports, but communicated visibly and repeatedly) to make the case that continuing in the same situation is more expensive than moving forward finding a solution.

- *Step 2 — Build a Guiding Coalition*: Management support varies significantly across markets, as the interviews in Chapter 4.6 CT Implementation Challenges revealed. Building a guiding coalition means identifying the people who already believe in the CT such as the managers in the PoC countries, the central logistics team, and the most vocal advocates from the interviews, and giving them a formal role in driving the implementation. This group needs enough positional power to make decisions, enough technical credibility to address skepticism, and enough geographic representation to prevent the change from feeling like a headquarters imposition on local teams.
- *Step 3 — Develop a Vision and Strategy*: Lindab needs a simple, honest narrative about what the CT means for the people working with it, not only a technical specification, but a picture of what daily operations look like once the system is running. Part of that picture is tangible and local: fewer trucks moving through Lindab's sites means less congestion in yards and loading docks, and while individual loading operations may take longer due to consolidation, the total time trucks spend on site decreases. This also has a direct safety implication, as fewer vehicles circulating inside the facilities reduces the risk of accidents for workers on the ground. This vision must also address the fair distribution of benefits and costs across entities, since the empirical analysis identified the perception of unequal impact as a key driver of local resistance. A vision that only speaks to global efficiency without acknowledging local realities will not land.
- *Step 4 — Communicate the Change Vision*: Given Lindab's decentralized structure, described in Chapter 1.2 Company Description, communication cannot be top-down and infrequent. The vision needs to reach warehouse operators, local logistics managers, and country-level leadership through multiple channels. Critically, the guiding coalition must model the behaviors they are asking others to adopt because if central leadership is not visibly using the CT, local teams will not either.
- *Step 5 — Empower Broad-Based Action*: Several structural barriers identified in Chapter 4.6 CT Implementation Challenges must be removed before local teams can meaningfully participate. ERP and TMS standardization is the most critical because sites that cannot connect to the system cannot benefit from it. Process standardization, data governance rules, and clear accountability mechanisms for updating the system are equally necessary. Without addressing these obstacles, asking employees to engage with the CT is asking them to work around their own infrastructure.
- *Step 6 — Generate Short-Term Wins*: The PoC is Lindab's strongest asset here. The savings and fill rate improvements already demonstrated in the pilot countries, outlined in Chapter 4.5, are living proof that the model works. These results should be communicated widely and celebrated explicitly. Beyond the PoC, identifying two or three quick operational wins in the next wave of countries such as improvements in the consolidation of trucks that increase fill rate and that also reduces urgent shipments, will sustain momentum and give skeptics something concrete to evaluate rather than resist.
- *Step 7 — Consolidate Gains and Produce More Change*: The risk for Lindab is declaring success once the PoC countries are running smoothly and stopping there. The deeper challenges: full ERP integration, data quality across all entities, KPI standardization and governance mechanisms, require sustained effort well beyond the initial pilot. The credibility earned through early wins should be used to push for these harder

changes, including the expansion of CT scope to inventory visibility and production coordination, areas where Chapter 4.7 Expected Benefits identified significant untapped potential.

- *Step 8 — Anchor New Approaches in the Culture*: The CT becomes permanent when working with it stops feeling like a change and starts feeling like the normal way of operating at Lindab. This means embedding CT metrics into performance reviews, making data quality a shared responsibility with clear ownership, and ensuring that new employees are onboarded into a culture where the CT is simply part of how things work. The skills and talent gap at local level identified in Chapter 5.1 is particularly relevant here: as CT responsibilities expand beyond the central team, training and capability development will need to be planned proactively, not reactively.

The conditions for a successful implementation are largely already in place at Lindab. The urgency is real, the early wins are documented, and the coalition is forming. Even that, barries identidied in Chapter 4.4.7, such as local resistance (highlighted for 12/18 interviewees), management suport (8/18 interviewees) and the correct treatment of organizational changes (6/18 interviewees) must be addresed roperly in order to assure the proper implementation, use and expansion of the CT. Therefore, what remains is the organizational discipline to follow through: treating the CT not as a pilot that may or may not scale, but as a strategic transformation the company has already decided to make.

5.4 Conceptual Model and Future Development of the CT at Lindab

After defining the CT requirements, it is useful to establish what it would actually manage in practice. This section analyzes the supply chain flows in Sweden that the CT would need to coordinate and subsequently explores how this implementation could evolve in the future.

5.4.1 Sweden CT Conceptual Model

Following the logistics savings calculations carried out in Chapter 4.2 and the PoC explained in Chapter 4.3, a conceptual model of the supply chain flow in Sweden was developed in order to identify the information and product flows that the CT would need to manage. This conceptual model is presented in Figure 21.

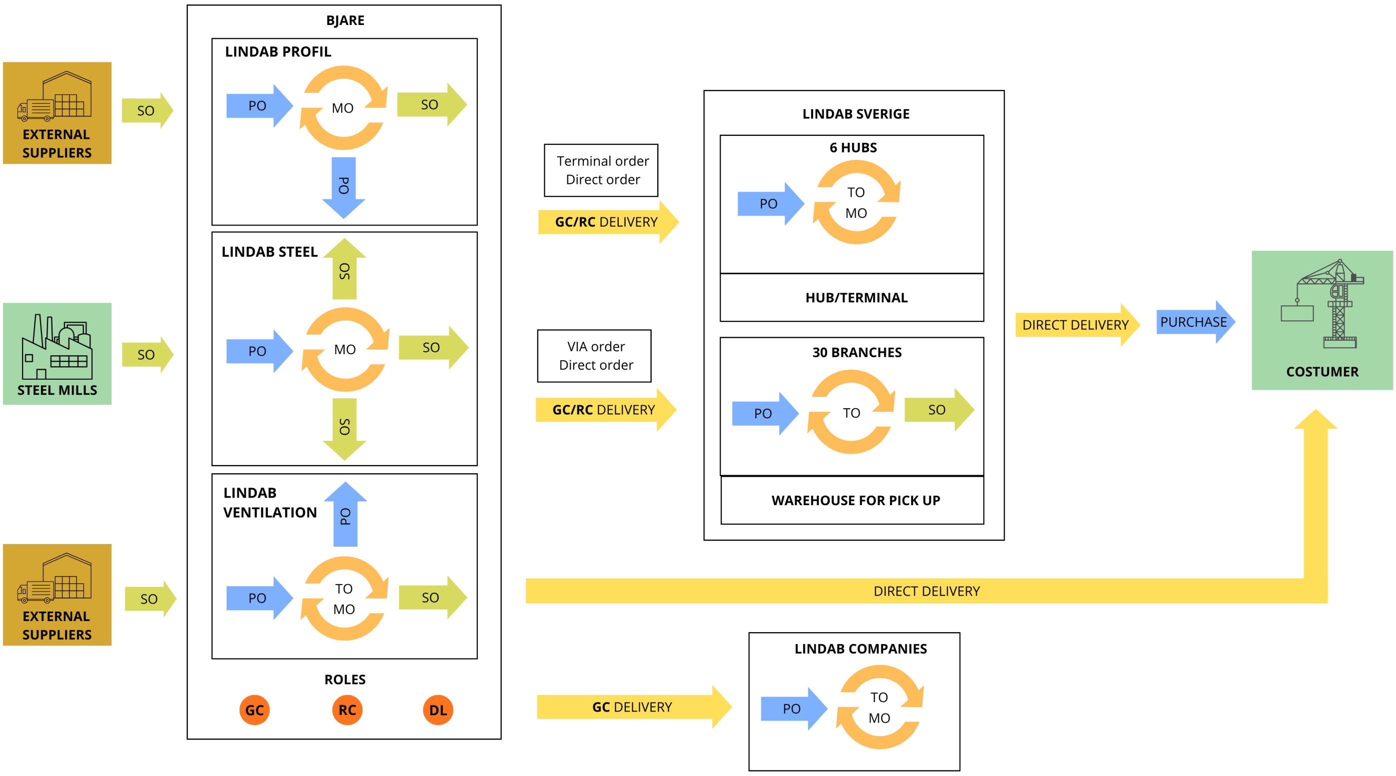


Figure 21: Conceptual Model of the CT in Sweden

First, the model includes external suppliers of materials and products that serve the central site in Bjäre, where the three companies, Steel, Ventilation, and Profile, are located. Within this site, Steel supplies processed material to both the Ventilation and Profile units. This site concentrates three different roles, as it can operate as a GC, RC or DL.

When Bjäre operates as a GC, it serves Lindab companies located in other countries, as well as Sweden itself. When it operates as an RC, it serves the Swedish market. Finally, when it acts as a DL, it serves customers directly, including sales points and external customers, such as construction sites, located geographically close to Bjäre.

Next, the different logistical possibilities that may arise at the GC site in Bjäre within this model will be defined in order to map the material flows and decision-making processes.

1. The central site supplies Lindab Sweden sites in order to replenish warehouse stock. This process is generated through the master planning system IMS in each site of Lindab Sweden.
2. A customer places an order at a Lindab Sweden site, and a PO is generated to the central site and there is a delivery to the warehouse. This can be caused because the site doesn't have the product available in the warehouse or because the lead time is enough for the central site to provide the product, being a cheaper option than taking the stock from the site.
3. A customer places an order and, since the product is not available in the warehouse, the site directly connects the supplier with the customer in order to perform a direct delivery without passing through the warehouse.

The conceptual model provides an overview of the main material and information flows that would need to be coordinated by the CT in Sweden. The model highlights the complexity of the different operational flows, entities, and order structures involved, as well as the importance of achieving centralized visibility and coordination across the network. A further analysis could include the structure and flows between the central unit in Sweden and the other countries supplied by this site. In addition, this model could serve as a guideline for the design of Regional CT in each country, helping to identify the main operational flows and information exchanges that need to be managed.

5.4.2 Future CT Expansion

Currently, as discussed in Chapter 4.3.2, the CT PoC is being carried out from the central site in Sweden (Bjäre) towards Norway, the UK, and Sweden itself. This constitutes a **Central CT** and **Regional CT** at the same time, since the Bjäre central site operates as a GC for a total of 12 countries across Europe as well as for Sweden itself.

In parallel, there is another central site located in Prague, Czech Republic, which acts as a GC for 13 countries. This site already applies truck filling rules for certain destinations; however, it has not yet reached the same level of operational approach as the CT currently implemented in Sweden. Therefore, the same model being carried out in Sweden could also be implemented there, creating a second **Central CT** and **Regional CT**.

Finally, in order to manage shipments within the same country, **Regional CTs** could be implemented in sites with an RC function. The objective would be to maximize shipment consolidation, both for last-mile deliveries to customers and for deliveries to other sites with a DL function, further improving transport efficiency and reducing logistics costs.

Taking into account the previous chapter, where the requirements can be observed, and Chapter 4.2, where calculations made it possible to identify which countries had the greatest potential for improvement, a CT implementation roadmap has been developed at both regional and local levels. In addition, before the full implementation, a series of activities must be carried out to ensure alignment with the project requirements. These include recruiting and training the right people, establishing SLAs and KPIs, developing the underlying processes and systems, and identifying local key partners in each market. These actions are a direct response to the skills gap, the lack of monitoring standards, and the integration barriers that the empirical analysis identified as the most significant obstacles.

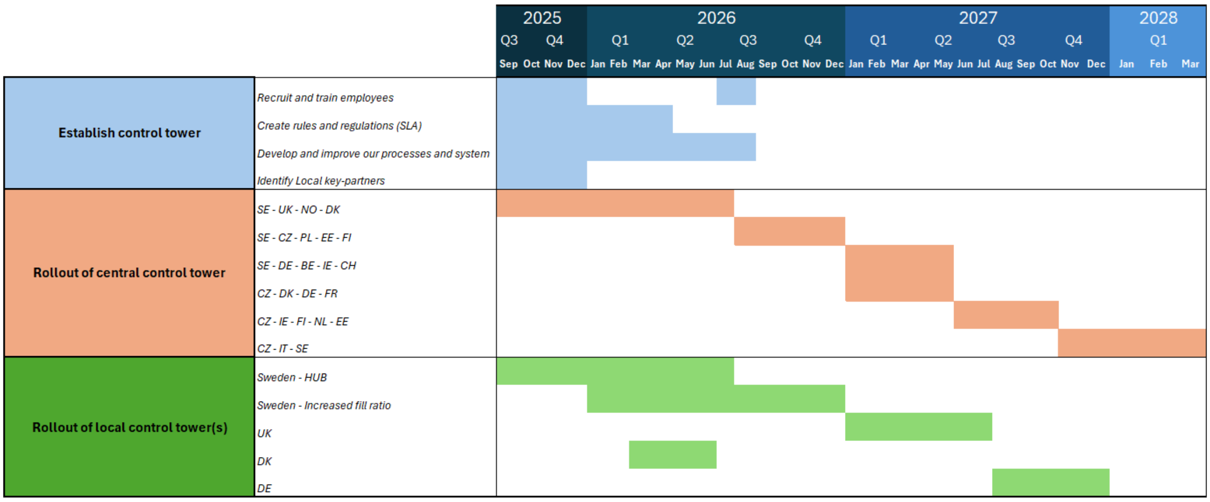


Figure 22: Future roadmap for the expansion of the CT at Lindab

The **Central CT** rollout is organized in six waves, sequenced according to a combination of operational readiness and the D365 implementation schedule across Lindab's entities. The first wave covers the first Central CT with the central in Sweden and delivering to UK, Norway, Denmark and Sweden itself which are the markets that already have CT capability today and will continue building on the PoC results. The second and third waves bring in Central and Eastern European markets. The fourth wave builds the second Central CT in Czech Republic delivering to Germany, Denmark and France followed by Northern European countries and later extending the model to Central and Southern European markets as their D365 implementation advances.

The **Regional CT** track focuses on Sweden, where the three Bjäre factories already operating under the PoC will continue developing their CT functionality, with hub optimization and fill ratio improvement as the primary objectives. Then other Regional CT rollouts in the UK, Denmark, and Germany are planned because of a high potential in consolidation at that level.

The Sweden Conceptual Model developed in Section 5.4.1 is a useful reference point for this process. The operational flows, order types, and site structures mapped for Sweden covering the GC, RC, and DL roles of the Bjäre site and the different SO and PO types that govern product movements offer a working blueprint that other markets can adapt rather than build from scratch. Each country will have its own specificities, but the underlying logic is largely transferable across Lindab's European network.

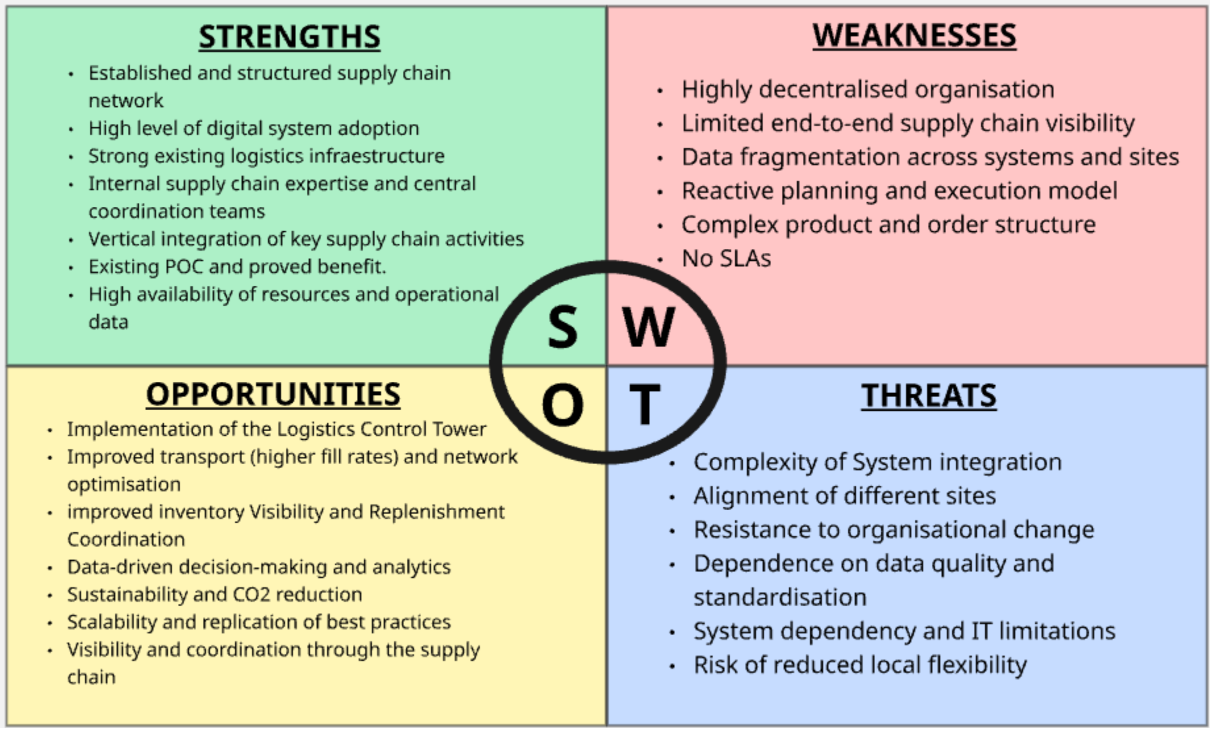
Getting the most out of this expansion means treating it as an organizational journey, not just a technical one. The change management roadmap in Chapter 5.3 and the implementation framework in Chapter 3.6.1 provide the structure for navigating that journey. The PoC proved the concept works. The expansion plan is how Lindab turns that proof into something that runs across its entire European operation.

5.5 Strategic Evaluation of the CT at Lindab

Once defined the functional requirements and data foundations of the CT, this section evaluates the initiative from a strategic perspective through two complementary tools: a SWOT analysis, which maps the internal and external factors shaping the implementation, and a Business Model Canvas, which translates the findings of this thesis into a coherent picture of how the CT creates and captures value for Lindab.

5.5.1 SWOT

The following SWOT analysis draws on the operational evidence gathered during the PoC and the perspectives shared by internal staff and external stakeholders throughout the interview process. It maps Lindab's internal conditions (what the company can build on and where the gaps lie) against the external factors that could either accelerate or complicate the full-scale CT deployment, as summarised in the following Table 23:



STRENGTHS

- Established and structured supply chain network
- High level of digital system adoption
- Strong existing logistics infraestructure
- Internal supply chain expertise and central coordination teams
- Vertical integration of key supply chain activities
- Existing POC and proved benefit.
- High availability of resources and operational data

WEAKNESSES

- Highly decentralised organisation
- Limited end-to-end supply chain visibility
- Data fragmentation across systems and sites
- Reactive planning and execution model
- Complex product and order structure
- No SLAs

OPPORTUNITIES

- Implementation of the Logistics Control Tower
- Improved transport (higher fill rates) and network optimisation
- improved inventory Visibility and Replenishment Coordination
- Data-driven decision-making and analytics
- Sustainability and CO2 reduction
- Scalability and replication of best practices
- Visibility and coordination through the supply chain

THREATS

- Complexity of System integration
- Alignment of different sites
- Resistance to organisational change
- Dependence on data quality and standardisation
- System dependency and IT limitations
- Risk of reduced local flexibility

Figure 23: SWOT Analysis of the CT Implementation at Lindab

Lindab enters this analysis from a position of relative advantage. The company operates a well, defined, multi-layer supply chain, from production facilities through to distribution centres and end customers, which provides the structural backbone that a CT requires, and this foundation is further reinforced by a high level of digital system adoption: tools such as the TMS, WMS, ERPs and IMS are already in active use, meaning the operational data a CT would depend on is largely available. Internal logistics expertise adds another layer to this picture, with dedicated teams that understand the supply chain in sufficient depth to support and manage a centralised coordination model. Importantly, the PoC has already demonstrated that the approach works within Lindab's own context, providing empirical grounding that goes beyond theoretical feasibility.

The main vulnerabilities are organisational and structural rather than technical. Lindab operates as a highly decentralised organisation with significant autonomy at the site level, a model that, while effective locally, limits network-wide coordination and visibility, and is compounded by data fragmentation across systems and sites that makes consolidation inconsistent and central decision-making more difficult. Ongoing efforts to unify ERPs across the organisation represent a step towards addressing this, though full standardisation remains a work in progress. The current planning model is largely reactive, responding to incoming orders rather than anticipating demand, a constraint that is, to a significant extent, inherent to the nature of the business rather than a failure of planning. The complexity of Lindab's product and order structure adds a further layer of variability that is unlikely to change. These are not weaknesses that need to be resolved before a CT can be implemented; they are the operational reality within which it will have to function, and acknowledging them is as important as addressing the ones that can be changed.

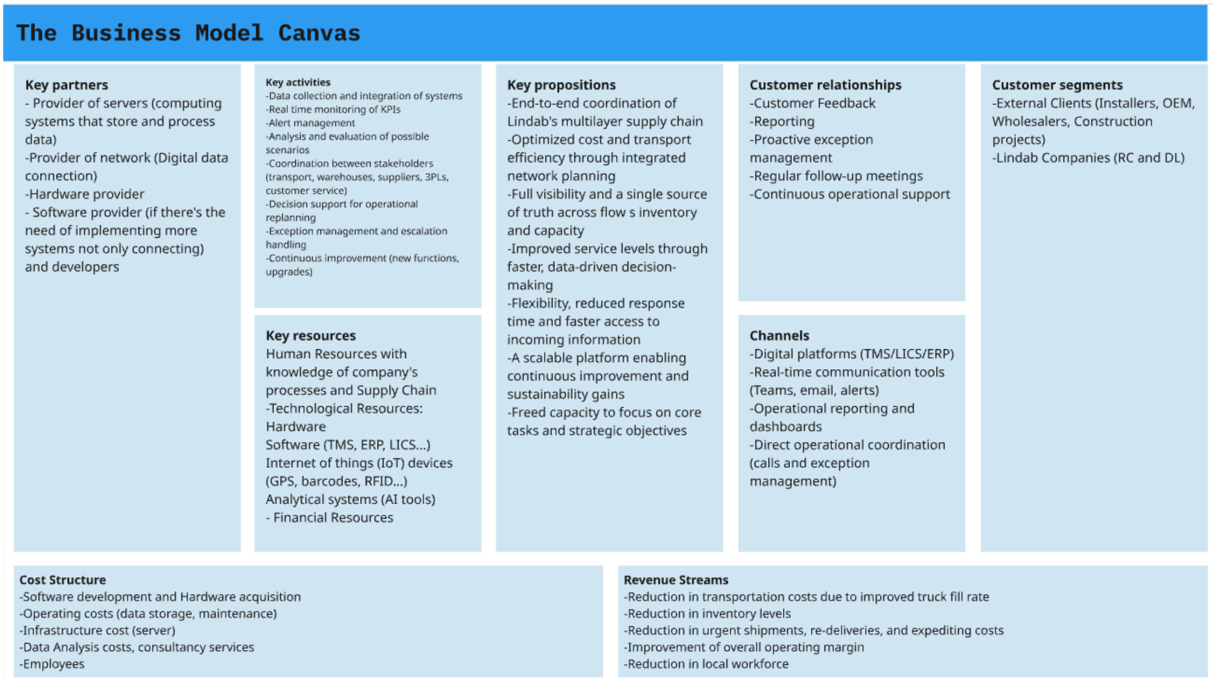
The opportunities that a CT would unlock are, in many ways, a direct response to the weaknesses identified above. Improved end-to-end visibility across the network would address the fragmentation that currently limits coordination, while enhanced inventory visibility would enable more proactive replenishment decisions, gradually shifting the planning model from reactive to anticipatory. Data-driven decision-making would further amplify this shift, providing the analytical foundation needed to improve forecasting accuracy and performance monitoring across the supply chain, and transport optimisation would translate these gains into immediate and quantifiable results: higher truck fill rates, better consolidation and more efficient routing all point to meaningful cost reductions, as the PoC has already begun to demonstrate. Beyond operational efficiency, the sustainability dimension is equally relevant: fewer and better-planned transport movements mean lower CO_2 emissions. Finally, the scalability of the model means that what works in one region can be systematically replicated across the European network, compounding the benefits over time.

The threats associated with a full-scale CT deployment are real, but they are implementation risks rather than fundamental objections to the initiative. The technical complexity of integrating multiple systems: TMS, WMS, ERP, across sites with different processes and data standards will require careful planning and sustained coordination, and this challenge is compounded by the organisational dimension: local sites accustomed to operating autonomously may perceive centralisation as a loss of control, making change management as critical as any technical decision. To mitigate this, the CT is planned to be rolled out gradually, with continuous communication of its benefits and active involvement of local teams throughout the process, an approach designed to build buy-in rather than impose change. The CT's effectiveness will also depend heavily on data quality and standardisation across sites, a condition that is not yet fully in place, though the ongoing ERP unification efforts discussed earlier represent a concrete step in that direction. Finally, there is a legitimate risk that excessive centralisation reduces local flexibility in markets with specific customer requirements, a tension that will need to be actively managed as the model scales.

The analysis, read as a whole, points in one direction. Lindab is not starting from scratch: the infrastructure, the expertise, and the empirical evidence from the PoC are already there. The weaknesses and threats require attention, but none of them are blockers; they are the conditions that a well-managed implementation will need to navigate. The opportunities, on the other hand, are both significant and achievable. For a company with Lindab's foundations, implementing a CT is not a risk, it is a logical continuation of work that is already ongoing.

5.5.2 Business Model Canvas

A Business Model Canvas is a useful way to step back and analyze if the implementation of the CT makes sense as a business preposition. After mapping Lindab's logistics challenges, defining the MAPE-K requirements, identifying the master data foundations the CT needs, and performing the SWOT analysis, Figure 24 brings those pieces together into a single picture of how a CT creates and captures value for Lindab.



The Business Model Canvas

Key partners
- Provider of servers (computing systems that store and process data)
-Provider of network (Digital data connection)
-Hardware provider
- Software provider (if there's the need of implementing more systems not only connecting) and developers

Key activities
-Data collection and integration of systems
-Real time monitoring of KPIs
-Alert management
-Analysis and evaluation of possible scenarios
-Coordination between stakeholders (transport, warehouses, suppliers, 3PLs, customer service)
-Decision support for operational replanning
-Exception management and escalation handling
-Continuous improvement (new functions, upgrades)

Key resources
Human Resources with knowledge of company's processes and Supply Chain
-Technological Resources:
Hardware
Software (TMS, ERP, LICS...)
Internet of things (IoT) devices (GPS, barcodes, RFID...)
Analytical systems (AI tools)
- Financial Resources

Key propositions
-End-to-end coordination of Lindab's multilayer supply chain
-Optimized cost and transport efficiency through integrated network planning
-Full visibility and a single source of truth across flow s inventory and capacity
-Improved service levels through faster, data-driven decision-making
-Flexibility, reduced response time and faster access to incoming information
-A scalable platform enabling continuous improvement and sustainability gains
-Freed capacity to focus on core tasks and strategic objectives

Customer relationships
-Customer Feedback
-Reporting
-Proactive exception management
-Regular follow-up meetings
-Continuous operational support

Channels
-Digital platforms (TMS/LICS/ERP)
-Real-time communication tools (Teams, email, alerts)
-Operational reporting and dashboards
-Direct operational coordination (calls and exception management)

Customer segments
-External Clients (Installers, OEM, Wholesalers, Construction projects)
-Lindab Companies (RC and DL)

Cost Structure
-Software development and Hardware acquisition
-Operating costs (data storage, maintenance)
-Infrastructure cost (server)
-Data Analysis costs, consultancy services
-Employees

Revenue Streams
-Reduction in transportation costs due to improved truck fill rate
-Reduction in inventory levels
-Reduction in urgent shipments, re-deliveries, and expediting costs
-Improvement of overall operating margin
-Reduction in local workforce

Figure 24: Business Model Canvas for the CT implementation at Lindab

The value proposition does not start from scratch, it is built directly on the operational reality described throughout this thesis. Every benefit listed maps directly onto a documented inefficiency: the transport utilization gaps, fragmented visibility, and reactive coordination analyzed in Chapter 4.1 Current Logistics Challenges at Lindab. The expected gains identified in Chapter 4.5 Expected Benefits of the CT Implementation: improved operational efficiency, better service levels, inventory visibility, and sustainability are what the organization itself identified as its most critical gaps, and the savings already demonstrated by the PoC confirm that capturing them is achievable.

The canvas also reveals a critical dependency: the revenue streams (savings in transportation costs, reductions in urgent shipments and failed deliveries, and the reallocation of workforce to higher-value tasks) only become real once the underlying operational foundations are in place. As analyzed in Chapter 4.6 CT Implementation Challenges, data quality, system integration, and organizational alignment are still the biggest barriers standing in the way. This is what makes the cost structure harder to understand: the investment goes beyond software and hardware, because standardizing processes, managing change, and bringing people along, all cost time and effort that rarely appears on a budget. But when those costs are weighed against what the PoC has already shown: better fill rates, fewer urgent shipments and lower operational costs, the investment stops feeling like a risk and starts looking like the logical next step.

The key resources and activities make clear that the CT is as much an organizational capability as a technical one. Human expertise (people who genuinely understand Lindab's supply chain processes) is just as critical as the technological infrastructure of TMS, ERP, IMS, and IoT devices. Without both working together, the core activities of the CT (real-time KPI monitoring, scenario analysis, exception management, and continuous improvement) simply do not work. This is also what makes the partnership decision important: whether Lindab builds the CT internally or through a mixed approach with a specialized provider will directly shape what resources are available, how fast implementation moves, and what it costs.

The customer segments, customer relationships, and channels blocks are closely connected. The CT focuses primarily on inter-site logistics flows (the movement of goods between Lindab sites) where consolidation is feasible and the efficiency gains are most significant. Last-mile delivery to end customers remains largely out of scope, given the consolidation constraints that come with serving dispersed locations. Within that focus, keeping the model working over time requires ongoing commitment: proactive exception management, regular follow-up meetings, and continuous operational support are what keep the network aligned and the system improving. The channels: TMS, IMS, ERP platforms, real-time communication tools, and operational dashboards are what make all of that visible and actionable for the people running the network day to day.

Overall, the canvas makes a clear case: the CT is a viable proposition for Lindab. The value it can generate is grounded in real operational data, the revenue potential is tied directly to inefficiencies the organization is already paying for, and the SWOT analysis in Chapter 5.3 SWOT has already identified the conditions under which that value can be captured. The remaining challenge is not whether the model works (the PoC has shown it can) but whether Lindab is prepared to treat the organizational and data quality foundations not as obstacles to manage, but as investments to make.

6 Discussion

This chapter reflects on the broader implications of the study, examining how far the findings extend beyond Lindab's specific context and what limitations may influence their interpretation. Acknowledging these boundaries is not a weakness of the research, it is what makes the conclusions credible and honest.

6.1 Generalizability of Results

This thesis is written in the context of Lindab's supply chain and, due to its complexity, the results present limitations regarding the generalization of this study. It is a single case study based on the use of 18 interviews, 15 of them conducted with internal employees of the company, which means that the framework within which the study was developed is highly specific and the results may not be applicable to other companies. However, this thesis can serve as a tool to compare characteristics and level of preparedness for implementing this CT system in supply chains, therefore companies with a similar organizational structure can use it as an initial reference to evaluate the feasibility, challenges, and opportunities associated with the implementation of a CT in their supply chain.

6.2 Comparison with Prior CT Implementations

Placing the findings of this thesis against what the literature already knows about CT implementations reveals where Lindab's case confirms existing knowledge, where it extends it, and where it quietly challenges some of the assumptions that underpin it.

On confirmation, the pattern of barriers identified at Lindab aligns closely with what the literature describes. Local resistance, insufficient management support, poor master data quality, and fragmented IT systems are consistently cited as the main obstacles to CT adoption (Freichel et al., 2022; Vlachos, 2021b), and all four appeared prominently in this study. The fact that 12 out of 18 interviewees flagged local resistance as a key barrier reflects a structural tension the literature identifies across industries: the difficulty of centralizing coordination in organizations that have historically operated with local autonomy. In this sense, Lindab's experience validates what the theory predicts.

Where this thesis extends the literature is in the conditions under which early benefits can be realized. Most CT implementation studies focus on organizations with relatively mature digital infrastructure (Chaffin et al., 2024; G. A. Smith, 2022). Lindab's PoC challenges that assumption: meaningful financial results (1,1 MSEK in net benefits) were achieved with a single planner, no system automation, and entirely manual conditions. This suggests that the threshold for generating value from a CT may be lower than the literature implies, and that organizations should not wait for full technological readiness before starting.

The case also sheds light on the relationship between implementation scope and results. The UK's PoC performance met and exceeded expected savings, while Sweden and Norway delivered partial results due to limited coverage. This illustrates something the literature rarely quantifies: the value captured from a CT does not scale linearly with coverage. The gains depend heavily on which nodes are included and how well they are connected, an insight that deserves more attention in future research.

Finally, there is one area where Lindab's case gently contradicts a common assumption in the CT literature: the idea that sustainability benefits are a natural byproduct of transport optimization (Din et al., 2026; Li, Miskon, Mohd Jamal, et al., 2024). In Lindab's context, sustainability was acknowledged as a benefit but was not a primary driver of the initiative, and the data collected did not include emissions tracking. This suggests that the link between CT implementation and sustainability outcomes, while theoretically sound, requires deliberate measurement infrastructure to become tangible, something that organizations in early implementation stages are unlikely to have in place.

6.3 Critique of Simplification of Literature

A key limitation of this thesis is the need to interpret and adapt existing literature that was not originally developed for a company like Lindab. Most research on CT concentrates in pharmaceutical logistics, third-party logistics, and large-scale retail, that represent operational contexts quite different from a decentralized and multi-country manufacturer. This means that benefits and barriers are often presented at a general level that does not distinguish between industry types or organizational structures. Some benefits consistently highlighted in the literature simply do not apply to Lindab, while some of its most critical challenges (such as managing a decentralized multi-ERP environment) receive little attention in existing research.

The same pattern runs through the specific frameworks adopted. The MAPE-K loop, borrowed from computer science, translates reasonably well to logistics operations but has not been widely tested in manufacturing contexts. The data quality standards were written for digitally mature organizations, making them a target state rather than a realistic baseline for Lindab. The SWOT is inherently static and subjective. The Business Model Canvas was designed for new business model creation, not for assessing an internal technological initiative. And Kotter's change management model was built for general organizational transformation, not for technology-driven implementations in complex multinational manufacturers.

Throughout the thesis, the authors have tried to be explicit about these adaptations and to ground them in the empirical findings where possible. The working assumption in each case has been that the underlying logic of the frameworks transfers to Lindab's context, an assumption that is reasonable and justified, but one that introduces a degree of interpretive simplification that readers should keep in mind.

6.4 Complexity of case study

This thesis is developed in the context of Lindab, a company that operates within a highly complex supply chain, involving multiple production stages, numerous companies and suppliers, and a presence across a large part of Europe. This complexity makes it difficult to fully understand all the aspects of the company that are relevant to the topic studied within such a limited time frame. Therefore, it should be acknowledged that, despite the supervision and efforts carried out during the study, misunderstandings, omitted aspects, or simplifications may still appear. Consequently, the results of this thesis should be interpreted while considering these limitations related to the context of the study.

6.5 Limitations of methodology

The topic of this project emerged from an idea proposed by the company as a way to validate and assess the suitability of implementing a CT within the company's supply chain, an initiative that was already being tested on a smaller scale. This approach is completely valid and provides value to the company; however, a different approach could perhaps have been adopted, since this way some evaluative capacity is lost. The company could instead have been selected as the object of study, starting with an analysis of the inefficiencies within the supply chain, and logistics in particular, and afterwards evaluating the possibility of implementing a CT or other alternatives that were not considered in the current case. This thesis fulfills academic objectives and provides significant value to the company, but from a purely academic perspective, it could perhaps have been developed with a broader point of view from the very beginning.

6.6 Researcher Reflexivity

Any research is shaped by the position of the people conducting it, and this thesis is no exception. As authors, we joined Lindab as Erasmus students for the duration of the project, which created a specific set of conditions that are worth being explicit about, both as a methodological strength and as a source of potential bias.

The proximity to the company was, in many ways, an asset. Being embedded within the organization gave us access to internal data, informal conversations, and a level of contextual understanding that would have been impossible to achieve through external interviews alone. Interviewees spoke more openly than they might have with purely external researchers, and the day-to-day exposure to the company's operations helped us interpret the data with nuance. The ability to follow up on interview responses in real time, to observe how decisions were made, and to participate in internal discussions added a layer of richness to the empirical analysis that a more distant methodology would not have captured.

At the same time, this proximity introduces risks that should be acknowledged. The closer a researcher is to the subject of study, the harder it is to maintain the critical distance that good research requires. Being part of the organization, even temporarily, may have inclined us toward validating the CT initiative rather than questioning it. The fact that the company proposed the research topic and had an ongoing interest in a positive outcome is a relevant context: it does not invalidate the findings, but it means that the conclusions should be read with that relationship in mind. We have tried throughout the thesis to present both the evidence in favor of the CT and the conditions and risks associated with it, but the reader should weigh our interpretation knowing that it was formed from inside the organization, not from outside it.

This is not an unusual situation in applied management research: embedded case studies are a recognized and valuable methodology (Yin, 2009). The key is to be transparent about it, which is what this section aims to do.

6.7 Research Contribution

Beyond its practical value for Lindab, this thesis makes a contribution to the academic literature on SSCTs that is worth stating explicitly.

The existing CT literature is heavily concentrated in specific industry contexts: third-party logistics providers, pharmaceutical supply chains, and large-scale retail operations (Chaffin et al., 2024; Harmelink, Topan, & van Hillegersberg, 2025; Liotine, 2019a). These are environments characterized by relatively standardized products, centralized IT infrastructures, and a clear separation between the logistics operator and the client. Lindab represents a fundamentally different context: a decentralized, multi-ERP, internal manufacturing organization operating across more than fifteen countries, where logistics coordination is fragmented by design rather than by accident. Applying CT frameworks to this kind of organization is not something the existing literature does in any systematic way.

By doing so, this thesis demonstrates both what transfers and what does not. The core logic of CT: centralized visibility enabling better coordination, transfers well. The specific assumptions embedded in many CT frameworks: mature data infrastructure, homogeneous IT systems, organizationally aligned stakeholders, do not. This gap between the theoretical ideal and the organizational reality is not a failure of the CT concept, it is a finding about the conditions under which that concept needs to be adapted to work. Identifying and documenting that adaptation is a contribution to the field.

More broadly, this thesis adds to a small but growing body of work that examines CT implementation in manufacturing contexts (G. A. Smith, 2022; Vlachos, 2021b). The combination of quantitative transport analysis, qualitative interview data, and a live PoC provides a richer empirical base than most published CT case studies, which tend to rely on either interviews or secondary data alone. Future researchers studying CT adoption in similar organizational contexts such as decentralized, multi-entity, internally fragmented, can use this thesis as a reference point for both the methodology and the findings.

6.8 Future Research

This thesis provides a solid foundation for potential future research on the topic. On the one hand, within the company context, the study has mainly evaluated the feasibility of implementing the CT at the central level in Sweden, with the possibility of extending this model to the central unit in Prague and others at local level. Another potential area of study would be the quantitative analysis of the potential of CTs in each country and the evaluation of their feasibility, since organizational models vary significantly across countries. Another possible research direction would be the study of the technological infrastructure required to support the CT, including the use of AI and the possibilities of implementing this infrastructure with the support of external companies, an idea that emerged during the conducted interviews. In addition, although this thesis has included transportation savings calculations, it has not analyzed the potential inventory savings. The thesis provides literature support and empirical findings regarding the benefits of inventory optimization, but a more detailed calculation could be interesting, taking the transportation analysis of this project as a reference.

From an academic perspective, further research on CTs is still necessary, as this remains a relatively new topic with a limited number of published articles. Furthermore, the existing literature mainly offers practical case studies, such as the one presented in this thesis, resulting in a lack of broader analyses regarding what drives companies to consider implementing this type of system, including its benefits, challenges, and architectures.

7 Conclusion

This chapter brings the study to a close by answering the research questions defined at the outset, drawing on the empirical findings and the literature reviewed throughout the thesis. It also offers concrete recommendations for Lindab on how to move the Control Tower initiative forward.

7.1 Answering Research Questions

RQ1: What structural and operational inefficiencies characterize Lindab's current supply chain, particularly in relation to transport utilization, inventory visibility, and cross-plant coordination?

Lindab's supply chain operates through a decentralized model where each site manages its own logistics independently. In many areas this works well, but in logistics it creates a fundamental problem: no single entity has a full picture of what the network is doing, and as a result, decisions that make sense locally often create inefficiencies at the network level.

The most visible consequence is low truck fill rates. Trucks leave sites with significant unused capacity because shipments are planned site by site rather than consolidated across the network. The same fragmentation produces duplicated transport flows, where multiple partially loaded trucks travel to the same destination independently, driving up freight costs and CO_2 emissions unnecessarily.

Inventory visibility follows the same pattern. Without a network-wide view of stock levels, each warehouse manages replenishment on its own terms typically maintaining 30 to 45 days of safety stock to avoid local stockouts, regardless of what other sites are holding. The result is duplicated inventory, slow-moving products accumulating across warehouses, and significant working capital tied up in stock the organization collectively does not need.

Another underlying issue is Lindab's fragmented IT landscape. Multiple ERP systems operate across different entities, data is stored in incompatible formats, and much of what the organization needs to plan effectively such as packaging dimensions, stackability configurations and pallet counts, exists only in the heads of experienced planners rather than in any system. Planning is manual, reactive and heavily dependent on individual knowledge. That is the operational reality the CT needs to change.

RQ2: How can a CT contribute to improving visibility, coordination, transport efficiency, and inventory management within Lindab's decentralized supply chain?

A CT addresses Lindab's inefficiencies by doing something the current setup cannot: giving the organization a single, real-time picture of what is happening across the entire network and the tools to act on it. By integrating data from ERP, TMS, WMS, and IMS systems into a centralized platform, the CT makes it possible to plan transport consolidation proactively, detect underutilized trucks before they depart and coordinate inventory replenishment from a network perspective rather than site by site.

The POC across Sweden, Norway and the UK demonstrates clear benefits under entirely manual conditions (one planner, working with basic tools and without automation). A fully implemented CT, with automated alerts, scenario analysis, and systematic governance, would multiply those results considerably.

For inventory, the CT enables the network-wide visibility that prevents local warehouses from over-stocking independently. With a shared view of stock levels, replenishment can be coordinated across sites, safety stock requirements can be reduced, and obsolete inventory can be identified before it accumulates. Moreover, the same visibility supports better production planning, more accurate demand forecasting, and a gradual shift from reactive to anticipatory operations, benefits beyond transport using the same data system.

At the organizational level, the CT connects silos that currently operate in isolation. Transport planners, stock controllers, warehouses, and production sites would share the same operational picture, making coordination possible, which was not possible in Lindab's decentralized structure before. The MAPE-K framework applied to Lindab's context formalizes this: monitoring deviations, analyzing root causes, generating response alternatives, and executing corrections while building institutional knowledge through every cycle.

RQ3: What is the business case for implementing a Control Tower at Lindab, and what organizational and technical conditions must be met for it to deliver value?

The inefficiencies are documented, the financial returns are demonstrated, and the infrastructure to build on is already there. Lindab's decentralized structure makes the CT more relevant because is it due to the network lacking coordination mechanisms that a centralized visibility and orchestration layer would deliver the most value.

The recommendation is not to pursue a full-scale transformation immediately, but rather to follow the gradual expansion approach outlined in Chapter 5.2.2. This involves first consolidating the current CT PoC, which addresses transport coordination and visibility, and then progressively expanding both geographically and functionally into areas such as inventory optimization and production coordination as the organizational and technical foundations mature. This recommendation is supported by the estimated savings, which correspond to approximately 14% at the central level and 25% at the Sweden Regional level. Furthermore, the PoC has already demonstrated that the concept is both feasible and capable of delivering tangible value. The proposed expansion plan therefore provides a structured path for scaling a proven solution into a coordinated capability that can support Lindab's operations across Europe.

However, moving forward depends on a few things. Local resistance was mentioned in 12 of 18 interviews, lack of management support in 8, and weak change management in 6. Additionally, ERP standardization, master data governance and proper change management are needed for the CT to deliver what the POC already shows it can do.

7.2 Recommendations and Future Research

The findings of this thesis point toward several concrete next steps for Lindab. The immediate priority should be master data governance. Packaging dimensions, stackability configurations, and pallet counts currently live in planners' heads rather than in any system and no CT can produce reliable outputs without that foundation in place. In parallel, ERP harmonization should run as a defined medium-term workstream. The CT can function as an integration layer in the short term, but as its scope widens, the cost of managing fragmented data across incompatible systems will grow and eventually become a ceiling.

Once these foundations are in place, the phased rollout defined in Chapter 5.4.2 provides a realistic expansion path: consolidate the Sweden operation first, then extend progressively toward inventory coordination and production alignment as organizational and technical readiness matures. Equally important is managing the human side of the transition. Local resistance was one of the most cited barriers across the interviews, a reminder that even a well-designed CT will underdeliver if the people operating it do not trust or embrace it. Involving site-level stakeholders early and communicating tangible wins clearly will be essential to sustaining momentum.

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9 Appendix

9.1 Appendix A: Interview Guide

(Note: The questions varied slightly depending on the expertise and role of the interviewee.)

Interviewee [Name], [Company name]

Date: 2026-xx-xx
Duration: xx min
Interviewee: [Name from Company name]
Purpose: Specific to the Interviewee

[To ensure that both parties involved in the interview share a common understanding of the purpose of the thesis and of what a CT represents, it is important to define the scope before starting. *Lindab is currently evaluating whether to continue with the implementation of the CT, using as a proof of concept (PoC) the pilot currently being carried out in Bjäre (Sweden). This initiative aims to address several aspects of the company that are currently generating logistics inefficiencies, particularly the potential for improving truck fill rates. In this context, a CT is understood as a central hub that improves coordination between different sites by providing end-to-end visibility across the supply chain.]*

Questions

1. Can you introduce yourself and your role in the company?
2. How would you describe a Control Tower?
3. How did the idea of implementing a Control Tower emerge?
4. What specific problems are you aiming to solve? What are the main KPIs that showed inefficiencies?
5. Were alternative solutions evaluated before deciding to implement a Control Tower?
6. How aligned is top management with scaling the initiative?
7. If Lindab decided to scale the Control Tower, where would you start? Should implementation happen in phases? What phases would you define?
8. Would you recommend internal development, external technology support or a mixed approach?
9. What fears do you think local sites might have regarding full implementation? Do you believe the implementation could lead to workforce reductions?
10. Do you anticipate resistance from management?
11. Do you think Lindab is culturally ready for more central coordination?
12. What is the biggest internal barrier to scaling?
13. What is the biggest risk with the full implementation?
14. Where do you expect the greatest financial and operational impact?
15. What parameters would you consider to determine whether the project has been successful?