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Developing a Decision-making Framework for Supply Chain Network Reconfiguration

A Case Study at Lindab

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Abstract

Title: Developing a Supply Chain Management Framework for Decision-making: A Case Study at Lindab

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Problem formulation: Taking decisions to facilitate an efficient supply chain could be difficult and include many parameters. As an international company, Lindab has a well-developed and rather complex supply chain network. However, in Lindab's current production- and distribution network resources are not used in an optimal way and Lindab does not known which decisions makes the optimal solution. In addition, it is not clear how different parameters are affected by changing the supply chain. To manage this issue and enable easier decision making regarding how to set up the supply chain, Lindab wishes to develop a decision-making tool for different parameters in the supply chain network, which in the future should contribute to the creation of a digital twin of their supply chain network.

Purpose: The purpose of the thesis is to build a framework which contributes as a decision-making tool for evaluating different parameters of flow within production and distribution at Lindab.

Research Questions: RQ1: How is Lindab's current supply chain network designed?, RQ2: What parameters should be included in the framework for decision-making?, RQ3: How do different parameters drive the design and redesign of the supply chain at Lindab?

Methodology: As the thesis is of exploratory nature, with the purpose of understanding which parameters that should be included in the framework, the selected research strategy was a case study. By doing a case study, the phenomenon was investigated within its real-world context by being done in Lindab's natural setting, including interviews, current data, and documents. In exploratory studies, both quantitative and qualitative data can be gathered, whereas qualitative data is predominated in this study.

Conclusion: Lindab has a well-established supply chain network in Europe, with central production in both Sweden and Czech Republic. The network is further divided into both four sales region and corresponding unit categories. Hence, a rather complex supply chain network, with many different interlinks. Through both conceptual literature research and industry research it was learned that the parameters important for decision making, was the parameters: *Costs, Country specific, Customer service, Efficiency, Health & Safety, Investments, Legal & Political, Measuring, Productivity, Products, Resilience, Savings,* and *Sustainability.* These contributed to the development of the framework consisting of the parameters and a corresponding phase for both quantifiable and non-quantifiable parameters. Further through testing, it was shown that the parameters in majority driving network redesign was the quantifiable, specifically parameters representing financials (costs, savings etc.), rather than customer service, sustainability, health & safety etc., even though they were just as represented by data availability. Hence, an indication of a pattern for redesigns solutions still highly dependable upon the historical approach of costs rather than several data driven parameters.

Keywords: *supply chain network, supply chain management, supply chain network design, supply chain reconfiguration, supply chain parameters, supply chain performance*, *change projects.*

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In connection to that, we would like to thank Lund University and specifically LTH and the corresponding Division of Engineering Logistics at the Department of Industrial Management and Logistics for supporting us and granting us the opportunity for finalizing our studies with this master thesis work.

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Louise Skaarup Johansen Michelle Jasinski

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1. Introduction

This chapter provides an overview of the thesis project. Firstly, the background of the subject area and a company description is presented. Thereafter, the problem formulation and the purpose are specified along with the research questions. Lastly, the delimitations and target groups are determined, and the report structure is outlined.

1.1 Background

It is well-known that a supply chain network is aimed to be in use for a significant time during which many parameters could change. Today, companies face many challenges that require quick, decisive, and accurate decision making. Due to networks ever-changing requirements referring to markets, cost factors, political and legal factors, networks need to constantly adapt (Lanza & Moser 2014). This issue calls for new technology and decision-making tools in order to stay competitive on the market. For many companies, digitalization and transformation of the company have been an ongoing process for many years. They simply need to do more to survive and ensure their competitiveness. Especially when the unexpected seems to be waiting "around the corner" more than ever (Brinch 2018). What companies are looking for are open, flexible and scalable ways to build resilient decision making. Resilient organizations are those that consistently innovate so that they can easily respond to minor disruptions and recover quickly from major disruptions. Technology can help the organizations find the best decision or decisions for a given business problem within a defined set of constraints.

A significant part of this is the modern supply chain's ability to generate large amounts of data. The enormous amounts of data open up great possibilities for optimizing the supply chain and thereby reducing or completely avoiding waste, delays, unnecessary stockpiling and environmental impacts (Brinch 2018). This requires a systematic collection of data and the application of advanced analysis techniques, algorithms and artificial intelligence. Data or analysis driven decisions enable companies to act fact based instead of relying on feelings and assumptions. It will enable companies to identify not just how something is performing, but also why it is performing the way it is, and due to which factors (Li & Liu 2019). The modern development is increasing the need for competitiveness on supply chain network in order to meet continuously different demands. If one has not already done so, now is the time to rethink the way one does supply chain business (Lanza & Moser 2014).

Lindab is along with others in the industry trying to be part of the technology era that base their decisions on analytical and data driven parameters and not on feelings and assumptions. Lindab in short wants to make smarter and more effective decisions based on data and analysis, and last but not least, they want to have an understanding of which parameters they have of importance for future reference. Technology for understanding these parameters have many different faces in these modern days, but one era of which Lindab also share increasing interest is the technology of having a digital twin in order to make smart and efficient decisions for future changes. A Supply Chain digital twin is a virtual representation of the real world. The live data captured can be used in multiple divisions and teams at Lindab to experiment with new approaches and what-if scenarios without disrupting actual production or processes. Essentially an integration of digital twin will enable Lindab to understand and monitor different parameters, hence provide the decision-making tool which they are longing to be granted (Marmolejo-Saucedo, Hurtado-Hernandez & Suarez-Valdes 2019).

Currently, Lindab does not have specific facts to back up a decision of where to produce and how to distribute in the best way. The challenge of this is something that they want to evaluate

and furthermore understand the supply chain footprint of the decisions they are making, in terms of different parameters like for example costs, delivery, reliability, emissions and other suitable measures. An understanding of parameters which shall contribute to the very start of the long-term goal of integrating a digital twin of Lindab's business.

1.2 Company Description

Lindab was founded 1959 in a small city in the southern part of Sweden called Grevie. This is also where the head office is located today. Lindab is a leading ventilation company with 5000 co-workers in 24 different countries around Europe. The company states that "*The indoor climate is crucial for how we feel, for our energy levels and whether we stay healthy. Lindab wants to contribute to the architecture and indoor climate of tomorrow. That is why we develop energy-efficient solutions for healthy indoor environments*" (Lindab Group 2022). Except ventilation solutions, Lindab also offers systems in sheet metal for rainwater systems, roof and wall products along with steel profiles for wall, roof and beam constructions. Lindab is divided into three areas; Lindab Profile is responsible for product development and production of building products, Lindab Ventilation is responsible for product development and production of ventilation products, and lastly Lindab Steel purchase and process steel.

Lindab Steel, located in Grevie, is the central purchaser of steel and purchases approximately 200 000 tons of steel per year. They supply steel, process it in the factory, and sells the processed steel to Lindab sites around Europe. The different Lindab sites are categorized into Group Central (GC), Domestic Central (DC), and Domestic Local (DL) and are responsible for production and distribution. The production- and distribution network is presented in figure 1.

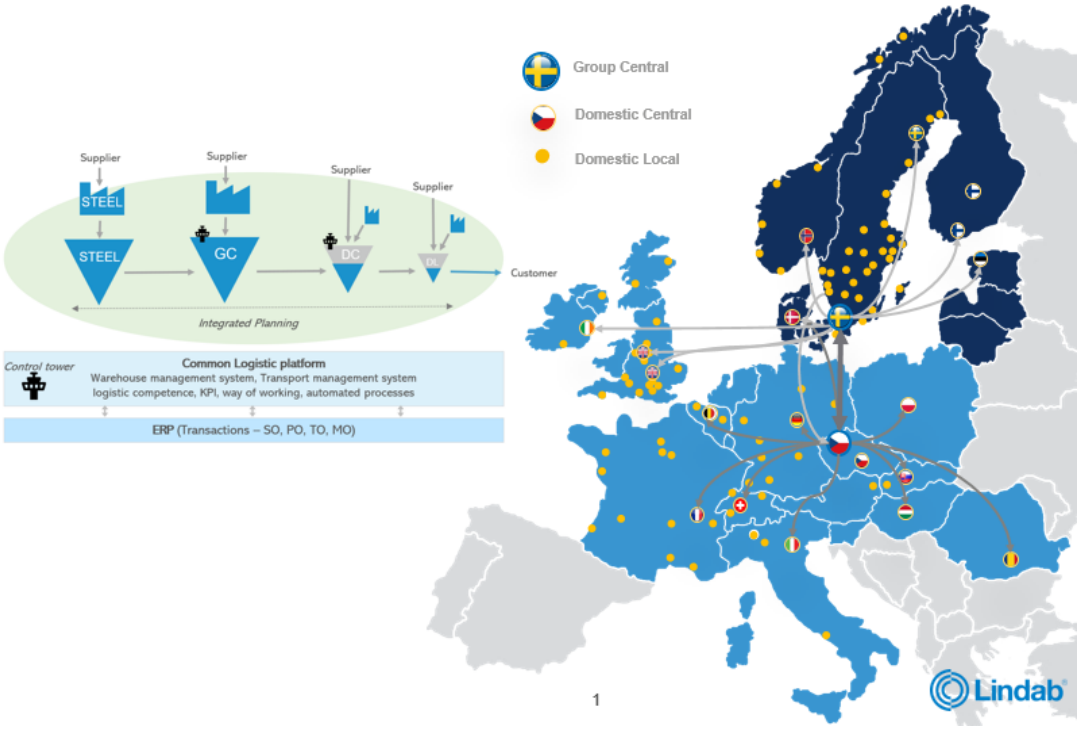


Figure 1. Lindab's production- and distribution network

Lindab has a great assortment of products, both ventilation and profile products. As this thesis will focus on products from the ventilation assortment, some of the mentioned ventilation

products in the thesis are presented in figure 2. The dimensions of products vary depending on required dimensions in building projects.

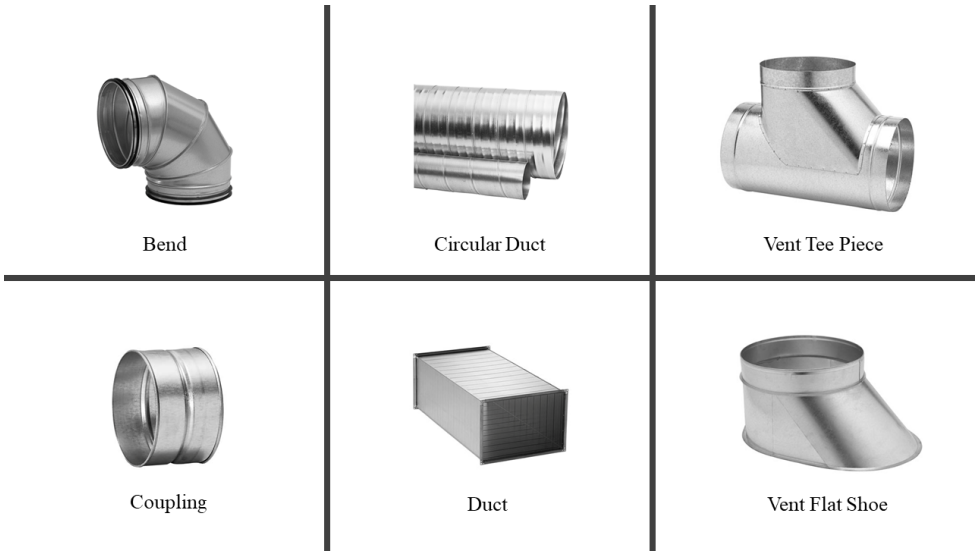


Figure 2. Ventilation products

1.3 Problem Formulation

Taking decisions to facilitate an efficient supply chain could be difficult and include many parameters. As an international company, Lindab has a well-developed supply chain network with their central production of steel and several production and warehouse sites: Group Centrals, Domestic Centrals and Domestic Locals. However, in Lindab's current production- and distribution network resources are not used in an optimal way. As of today, Lindab does not have all the facts regarding which location is optimal to put their production or how to distribute most efficiently. In addition, it is not clear how different parameters are affected by changing the supply chain. To manage this issue and enable easier decision making regarding how to set up the supply chain, Lindab wishes to develop a decision-making tool. The company is aiming to create a digital twin of their supply chain network, but since our master thesis will be the starting point of this project, this is not our goal within the time frame of the master thesis. Our goal will be to provide Lindab with information and create a framework that will contribute as a tool to make the right decisions in relation to different parameters.

1.4 Purpose

The purpose of the thesis is to build a framework which contributes as a decision-making tool for evaluating different parameters of flow within production and distribution at Lindab.

1.5 Research Questions

In the following, the research questions (RQ) of which contributed to the work of the thesis is outlined. Firstly, RQ1 aims to describe and introduce the context and current state of the supply chain network at Lindab, of which is researched in the thesis work. Secondly, RQ2 aims to gather information, data and insights on parameters of interest from both acknowledged recent research, interviews with employees at Lindab and historical data from Lindab change projects. Lastly, RQ3 aims to contribute to the analytic part of which parameters and how they should be included to deliver a successful framework.

RQ1: *How is Lindab's current supply chain network designed?*

RQ2: *What parameters should be included in the framework for decision-making?*

RQ3: *How do different parameters drive the design and redesign of the supply chain at Lindab?*

1.6 Delimitations

For the thesis work to successfully contribute to Lindab and research in general, some delimitations were considered relative to the work. First of all, the work was limited to the time of 20 weeks, hence the goals of the thesis had to be realistic to look into in those 20 weeks. In the nature of that, some things had to be prioritized and others may be of aspects for future research.

The general topic of research is to investigate how different parameters act in Lindab, when change projects are conducted, with the essential goal of building a framework for future reference. As Lindab is a large company, the work and focus were only on ventilation products in order to scope the project in a successful manner. In the nature of that, a delimitation occurs in the aspect of who was interviewed for the thesis work, as that is only employees with deep knowledge about Lindab's supply chain. These employees possess high positions in the Lindab organization with several years of employment. Moreover, the selection of employees has been made to fit the scope of the project, hence a delimitation in the findings will be relative to the positions and divisions of which the selected employees represented. Additionally, a delimitation of the scope of the thesis work is present, specifically evolving that the goal and purpose of the work is to develop and test a framework and not to evaluate specific historical project decisions within Lindab.
Lastly, a delimitation of confidentiality matters is resulting in specific data and numbers used for investigating and concluding on the research questions are not enclosed in the thesis report. Resulting in a more general representation of the problem of interest rather than a specific and detailed representation.

All of the aforementioned delimitations should be recognized as both a tool used to scope the project in order to success in the works goals, but also an acknowledgement that findings in theory might not cover all of the departments in the Lindab organization. Though it is believed that the scope of the work can be used to generalize to some extent.

1.7 Target Group

The thesis is created for Lindab with the intention to deliver a framework acting as a decision-making tool based on the most important parameters in Lindab's production- and distribution network. Besides Lindab, there are two other potential target groups that could be of relevance.

Companies in the same industry could take advantage of the framework developed for Lindab since many parameters are not company specific but industry specific. Any company seeking to understand which parameters that could affect their production- and distribution network could find this thesis valuable.

Academia could also benefit from reading this thesis as literature has been merged and combined with company specific parameters which provides a practical aspect of supply chain networks. The gathered information and framework can be of relevance when doing further research on supply chain networks.

1.8 Report Structure

Table 1 gives an overview of the report together with a short description of each chapter.

Table 1. Structure of the report

1.	Introduction	*This chapter provides an overview of the thesis project. Firstly, the background of the subject area and a company description is presented. Thereafter, the problem formulation and the purpose are specified along with the research questions. Lastly, the delimitations and target groups are determined, and the report structure is outlined.*
2.	Methodology	*This chapter include the methods used for conducting the thesis. The chapter begins with the reasoning behind the research strategy followed by the research design. The research design and method describe the thesis procedure with support from theory. Lastly, the research quality is defined, describing the research validity and reliability.*
3.	Literature Review	*This chapter presents the theoretical findings based on the literature review. Firstly, theory on supply chain redesign is presented to provide an understanding of different influencing factors that drive change in a logistics context. Thereafter, considerations in supply chain change projects are described to give an overview of different parameters and factors considered in these types of projects. Lastly, more detailed theory is provided regarding specific parameters in the supply chain network. The chapter is finalized with a conceptual framework where the theoretical parameters are summarized.*
4.	Empirical Data	*This chapter consists of information about Lindab's supply chain network followed by the empirical data collected through interviews with Lindab employees. The supply chain map is presented with the purpose of giving the reader an understanding of how Lindab's supply chain network is designed today. The interview data gives an understanding for change projects and important parameters in the supply chain network.*
5.	Analysis	*In the following chapter, the findings from the interviews are analyzed, in connection with literature to compare theory and empirical data. Firstly, change projects discussed during the interviews are analyzed to understand relevant redesign options. Thereafter, the important parameters are analyzed through a thematic analysis. This is done by categorizing parameters to facilitate the understanding of different types of parameters. Lastly, the result of the most important parameters, empirical data and theory combined, are presented.*
6.	Developing the Framework	*In this chapter, the process for developing the final framework is structured. This includes the framework logic and approach along with the first version of the framework. Furthermore, two real-life cases at Lindab are used to test the framework, find improvement areas and to analyze the usage of the framework. The chapter is finalized with a summary of modifications needed to complete the final framework.*
7.	The Final Framework	*This chapter presents the final framework that has been developed along with the suggested process for using the framework.*
8.	Discussion	*This chapter discusses the generalization of results, the limitations of the framework, and recommended future research and usage of the framework.*
9.	Conclusion	*In this chapter, the research questions are answered and further recommendations of suggested actions for Lindab are presented.*

2. Methodology

This chapter include the methods used for conducting the thesis. The chapter begins with the reasoning behind the research strategy, followed by the research design. The research design and method describe the thesis procedure with support from theory. Lastly, the research quality is defined, describing the research validity and reliability.

2.1 Research Strategy

This thesis is aiming to support Lindab to take the right decisions in relation to different parameters in their supply chain network. Reconfigure the supply chain and stay competitive on the market is always a challenge for companies, but the number of frameworks in research regarding which parameters that should be taken into consideration when doing a change is limited. When there is little or no scientific knowledge about a phenomenon, researchers aim to explore and examine the situation to gain further understanding and discover new elements (Stebbins 2001). The goal of exploratory studies is to generate new ideas and then merge them together to form grounded theory (Stebbins 2001). This consideration can also be adapted into the Maturity cycle of research developed by Malhotra and Grover (1998). They argue that the progress of research in a subject area increases the certainty or understanding with respect to knowledge. According to Malhotra and Grover (1998), exploratory or descriptive studies are appropriate in early stages of research and as research matures relationships among variables can be studied.

As the thesis is of exploratory nature, with the purpose of understanding which parameters that should be included in the framework, the selected research strategy is case study. Presented in figure 3, the thesis is positioned in the maturity cycle of research. Case studies are used in many situations to contribute to our knowledge of individual, group, organizational, social, political, and related phenomena. By doing case studies, the phenomena can be investigated within its real-world context (Yin 2014). As this study is done in Lindab's natural setting, including interviews, current data, and documents, a case study stands suitable. Using case studies to build theory involves several data sources (Eisenhart & Graebner 2007) and some of the most common sources of evidence are documentation, archival records, interviews, and direct observations (Yin 2014). In exploratory studies, both quantitative and qualitative data can be gathered, whereas qualitative data is predominated (Stebbins 2001).

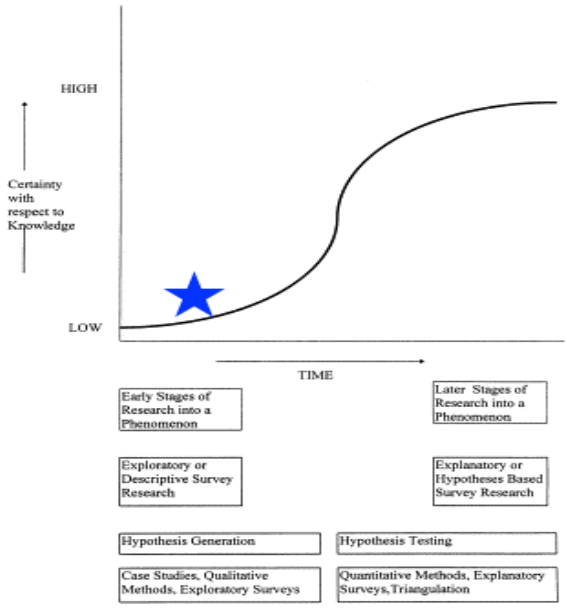


Figure 3. The thesis positioned in the Maturity cycle of research developed by Malhotra and Grover (1998).

Building theory from case studies involves studying one or several cases, also called single case studies or multiple-case studies. Using multiple case studies provides a stronger base of theory that is more accurate and generalizable, while single case studies provide more in-depth knowledge about a certain phenomenon (Eisenhardt & Graebner 2007; Voss, Tsakriktsis and Frohlich 2002). In addition, the unit of analysis should be specified to define the case to be studied (Yin 2014). The unit of analysis of this thesis is Lindab's supply chain network while the phenomenon is supply chain redesign and parameters connected to supply chain design.

2.2 Research Design and Method

The research is conducted as a single case study with the focus on Lindab's supply chain. A literature review was done to gain insight on current knowledge in the subject area of supply chain redesign along with considerations and parameters in supply chain networks. To understand the supply chain of the organization, data has been collected through interviews with Lindab employees. Thereafter, data has been analyzed through a thematic analysis. In the concept development, the findings and learnings from the data analysis were tested in a suitable context and environment, in order to develop the concept of which act as the basis for the final framework.

2.2.1 Single Case Study

According to Voss et al. (2002), case research is one of the most powerful tools when developing new theory. However, there are several challenges with case studies as well. Typical challenges, mentioned by Voss et al. (2002), are that it is time consuming, it is difficult to select the most appropriate interviewee, the possibility to generalize results, and ensuring accurate results. This study is approached as a single case study. A single case study provides in-depth knowledge about a certain phenomenon (Voss et al. 2002); Eisenhart & Graebner 2007) and contributes as input for new scientific knowledge about a large group of phenomena (Swanborn 2010). The limitation of generalizability and the risk of misjudging a single event are common disadvantages with single case studies (Voss et al. 2002; Eisenhart & Graebner 2007). As argued by Eisenhart and Graebner (2007), theoretical sampling is key to respond to these challenges. Theoretical sampling, in single case studies, means that cases are selected because they are suitable in terms of relevance, extreme examples, or opens the opportunity for unusual research access.

For this thesis, the single case study has been conducted at Lindab. The reason for choosing Lindab as a single case is to study their supply chain network in particular and achieve greater depth in their situation with the purpose of delivering a framework for evaluating parameters in the supply chain network. To answer the research questions, it is necessary to gather information from interviews, company data, and literature. By interviewing employees at Lindab we achieved greater knowledge about their supply chain network along with different parameters they consider important. In addition, information regarding historical change projects in Lindab's network have been gathered through the interviews to understand the reason for former changes and which parameters that were considered. The combination of interviews, company data, and the literature review contributes as input for building the framework for Lindab.

2.2.2 Literature Review

Doing a literature review is an important part of research to gather information on a subject area (Rowley & Slack 2004). By reviewing the literature, the researcher can explore current knowledge on the topic and identify state-of-the-art in the subject area. The studied subject area

in this thesis is supply chain redesign and parameters affecting the supply chain network, whereas the search words are a combination to find relevant literature.

The search for literature has been done using the database LUBsearch provided by Lund University, complemented by Google Scholar and relevant physical books. Key words when searching for literature were for example, “supply chain network design”, “supply chain redesign”, “supply chain reconfiguration”, “supply chain parameters”, “production network”. “supply chain change projects”, “supply chain changes”, “supply chain performance” among others.

The literature search has been done according to Rowley and Slack (2004) five-step methodology for conducting a literature review:

1. *Scanning documents* – the starting process of getting familiar with the documents in the area of the research topic. By scanning documents this will provide the researcher with insights of key themes that should be included in the literature review.
2. *Making notes* – when reading literature, the researcher should take notes and mark up the document to identify key themes and messages.
3. *Structuring the literature review* – when key themes have been identified in the literature, the documents should be organized and structured accordingly.
4. *Writing the literature review* – according to the structure in stage 3, the different sections in the literature review should be written.
5. *Building a bibliography* – this is an ongoing process from the beginning of the literature search to keep track of all read documents and their source.

When iterating the process, we identified the subject area as broad and authors phrasing the subject area using different terms. When scanning documents, both the heading, abstract, and reference list were of interest to see the relevance of the paper but also which papers that has been referred to in order to facilitate the literature search.

2.2.3 Data Collection

The empirical data has been collected through interviews with Lindab employees. The most suitable people in the organization were chosen and interviewed to provide insight in the supply chain network and gain a further understanding of what parameters they consider important today. The people who were interviewed are highlighted in the table below (table 2). All interviews were conducted via the online platform TEAMS and lasted approximately 1 hour. The approach for the interview was a semi-structured interview with some pre-defined questions, but the questions were also used to inspire discussion. The interview questions can be seen in Appendix 1.

The semi-structured interview is an interview in which we as interviewers used an interview guide (the interview questions). The guide thus had a number of questions that needed to be answered during the interview. The order of the questions was open to variation, and with possibility to ask in-depth questions. The method gave us as the interviewers an opportunity to manage the interview, while the respondent was free to answer the questions and elaborate in the preferred manner. The semi-structured interview was used with advantage to gather as much information and insights as possible from one interview, with then goal of touching upon all the key topics and areas, along with allowing self-reflection and opinions from the respondents (Rowley 2012).

To verify the information and ensure that the collected data from the interviews were correct, the interviews were recorded with the interviewees' permission. The information was then transcribed into protocols and each interview was summarized into the case study report.

Table 2. Case study interviews

Interviewee	Role	Date
Candidate A	Manager of Group Production Development and Operations	2022-01-25
Candidate B	Strategic Product Manager	2022-02-01
Candidate C	Senior Strategic Sourcing Manager Freight	2022-02-02
Candidate D	Logistics Developer	2022-02-04
Candidate E	Logistics Developer	2022-02-07
Candidate F	Operational Director	2022-02-07
Candidate G	Inventory Manager	2022-02-07
Candidate H	Management Director	2022-02-09
Candidate I	Regional Operations Manager	2022-02-09
Candidate J	Managing Director	2022-02-10
Candidate K	Regional Operations Manager	2022-02-10
Candidate L	Sales Region Manager	2022-02-14
Candidate M	Industrial Manager	2022-02-14
Candidate N	Regional Director	2022-02-17
Candidate O	Logistics Manager	2022-02-21
Candidate P	Managing Director	2022-03-04

2.2.4 Data Analysis

Qualitative research deals with a great amount of data created by interview transcripts, field notes, collected documents, and other records (Gibbs 2007). As this is a qualitative single case study including interviews, a thematic analysis has been conducted. A thematic analysis is used to identify, analyze, and understand themes (patterns) within data (Braun & Clarke 2006). When doing a thematic analysis, different patterns are explored that are important in relation to the research questions and for describing the phenomena. In addition, when doing a thematic analysis, the subject area can be understood more widely (Braun & Clarke 2006).

In general, analyzing qualitative studies are done in three steps (Gibbs 2007): data reduction, data reorganization, and data representation. This thesis follows the six-step-model for doing a thematic analysis developed by Braun and Clarke (2006):

1. *Familiarization* – get familiar with the collected data by reading, re-reading, and noting initial ideas when transcribing interview data.
2. *Coding* – organize data into meaningful groups (codes) when repeated patterns are identified. Could be done by coloring and highlighting potential patterns in the data set.
3. *Searching for themes* – when different codes are identified, they should be sorted into potential themes. At this stage, codes could form main themes, sub-themes, or be discarded. The themes could be visualized in tables or mind-maps.
4. *Reviewing themes* – the identified themes need to be verified with the original data to ensure that the themes are representative and if the codes are categorized in the correct theme. Otherwise, further reviewing and refining of the coding and themes needs to be done.
5. *Defining and naming themes* – identify the essence of each theme and clarify the name and definition.
6. *Producing the report* – final analysis and write-up of the report.

2.2.5 Concept Development

Management tools can be defined as a framework, procedure or method that enables a company to achieve an objective (Brady et. al 1997). According to Phaal, Farrukh and Probert (2004), tools are related to practical application and frameworks to conceptual understanding. To develop a framework, a 'process approach' is suggested to emphasis the need of an iterative and controlled development procedure. Typically, several phases are included in the concept development process where Phaal, Farrukh and Probert (2006) state three general phases: exploratory, development, and testing. The development of the framework in this thesis is based on those three general steps but modified to a more detailed level.

Firstly, data was extracted from the analysis to identify the most important parameters that should be included in the framework. Thereafter, the first version of the framework was developed in Excel. To verify and improve the framework, two Lindab case projects were used to test the framework. Information about the cases were collected along with data that was applied into the framework. The test results were later used to revise the framework and lastly generate the result of the final framework. The concept development process is presented in figure 4.

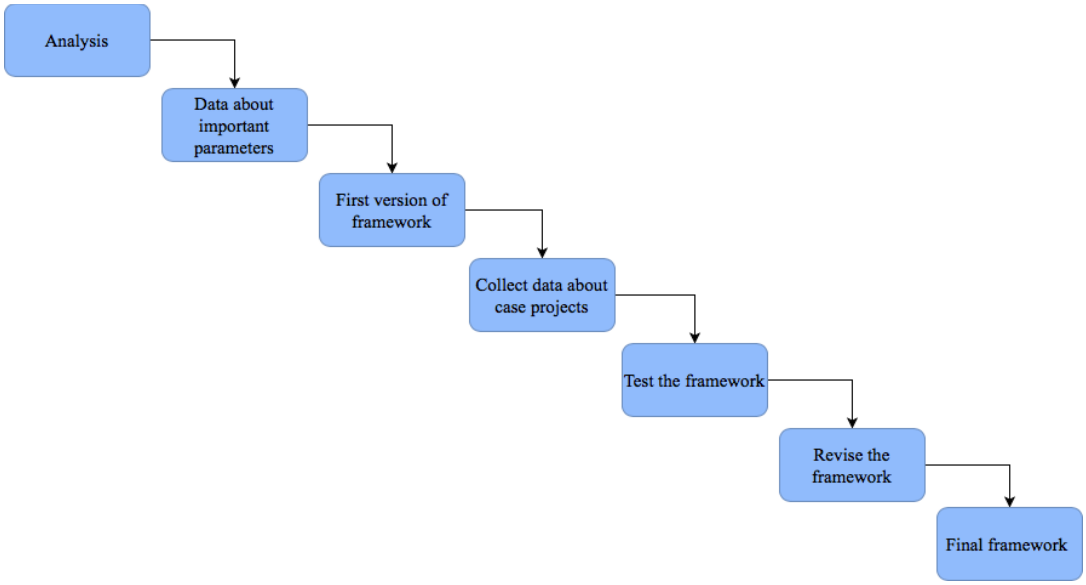


Figure 4. Concept development process (Source: own figure)

2.3 Research Quality

There are two concepts in particular that one considers when talking about scientific research and its corresponding quality, it is validity and reliability. In scientific research, the quality of your research is measured. In this connection, the concepts of validity and reliability are used. In short, validity is about whether we have examined the presented questions in the problem formulation, and reliability refers to the quality of the data that we have obtained (Roberts & Priest 2006).

2.3.1 Validity

Firstly, diving into validity in relation to our work with theoretical research and data collection, we distinguish between constructed, internal, and external validity (Gibbert & Ruigrok 2010). With constructed validity it refers to the most theoretical type of validation. It refers to the hypothetical concept that is assumed to lie behind the area that the research work is to cover (Gibbert & Ruigrok 2010). For this matter a literature review based on multiple references and constructing of a conceptual framework summarizing the findings from the literature, act as the contractual validation of the thesis work.

Internal validity is related to the issue of causality. Meaning it is the conclusion regarding the relationship between two or more variables true. The internal validity can be translated with credibility in the qualitative studies that refer to the credibility of the results (Golafshani 2003). Hence, in our setting, interviews with employees at Lindab, of which are the groundings for the empirical data in the thesis work, contributed to internal validation of each other and was thereby used as validation of the findings and conclusions. Furthermore, by finding patterns among the empirical data and the theoretical framework of which is gained in the thesis work, internal validation was achieved for the work.

Lastly, the external validation, referring to the generalizability of the results. Meaning, if the results can be used in other contexts, and do they say anything in general about patterns and prioritizations along with the boundaries for the generalizations (Gibbert & Ruigrok 2010). For the work of this thesis, the external validity was in the use of theory, which also was used in other single case studies in order to use replication logic, hence externally validate possible generalization domains.

2.3.2 Reliability

Basically, reliability is about whether an experiment or research with a completely similar framework will give the same results the second time it is conducted. Hence, the greater the consistency between data from different sources, the greater the reliability of data (Gibbert & Ruigrok 2010). For the matter of this thesis work the reliability is accommodated for as high a success as possible by the generation of case study protocols and development of case study database. Hence, the methodology approach and its corresponding procedures used in this thesis research acts as the protocol of procedures used for collecting the data in the thesis work, hence the research protocol. Along with the protocol, a setup of case study database was used to compromise the data collected from both interviews and literature sources. Hence, tables, conceptual framework and other findings were summarized into a database in order to extract useful findings which essentially contributed gaining reliability and to the overall purpose of building a framework.

3. Literature Review

This chapter presents the theoretical findings based on the literature review. Firstly, theory on supply chain redesign is presented to provide an understanding of different influencing factors that drive change in a logistics context. Thereafter, considerations in supply chain change projects are described to give an overview of different parameters and factors considered in these types of projects. Lastly, more detailed theory is provided regarding specific parameters in the supply chain network. These parameters are fundamental for developing the framework. The chapter is finalized with a conceptual framework where the theoretical parameters are summarized.

3.1 Supply Chain Redesign

The growth of global supply chains has consequently made companies compete as supply chains rather than individual businesses (Christopher 2016) making the focus on efficient supply chains and their processes important. Authors argue that, in modern organizations, the need to change processes in the supply chain, change how supply chain functions interact internally, and change the way functions interact with actors externally is key to survive on the market (Van Hoek et al 2010). Supply chain reconfiguration involves decision on facility location, relocation, amount of capacity at each location, investment, disinvestment, technology upgrade, production-allocation, distribution etc. (Chopra & Meindl 2013; Naraharisetti & Karimi 2010).

There are several factors that drive international companies to reconfigure their supply chains, these could be external or internal factors. External factors are unpredictable and uncontrollable events while internal factors are motivated by inefficient processes (Barbosa & Musetti 2011). Authors like Dev, Shankar and Dey (2014), Lemoine and Skjoett-Larsen (2004), and Rushton, Croucher and Baker (2022) mention global competition, increased focus on market requirements, advances in information and communication technology, and development in international freight transport systems as some of the main drivers. As the global competition increases, companies relocate their plants and distribution centers to remain competitive and cost-efficient (Lemoine & Skjoett-Larsen 2004). The pressure of short lead times, whereas 24-48h lead time is a common requirement in Europe, makes companies reorganize their production and distribution system (Lemoine & Skjoett-Larsen 2004). Other observed drivers for change are sustainability, especially environmental sustainability where the importance of reducing CO_2 emissions and other green issues are highlighted, shortening of product life cycles, and regulatory and political changes (Rushton, Croucher & Baker 2022). Figure 5 presents different pressuring factors influencing logistics systems that consequently drives change.

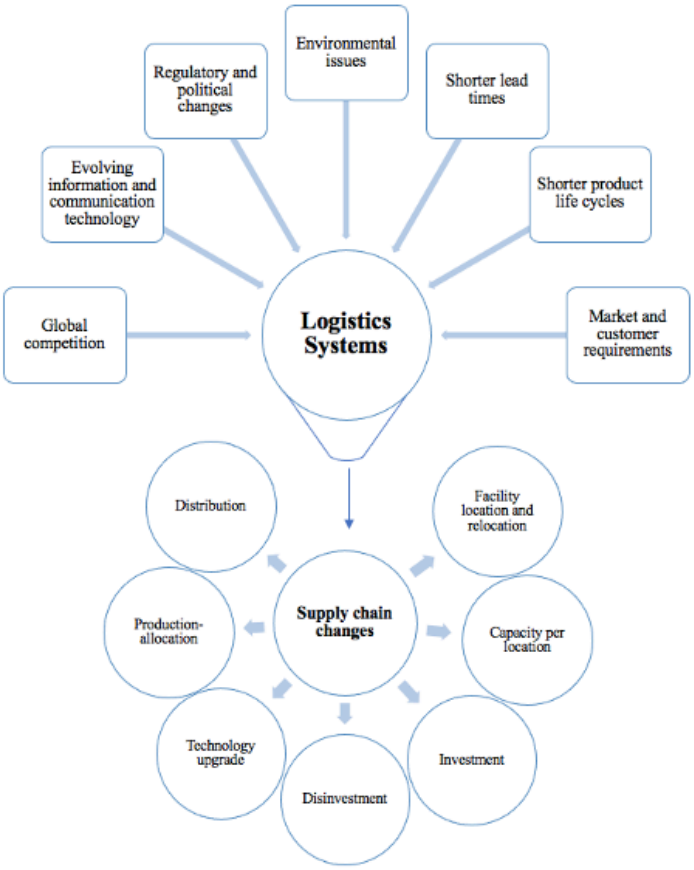


Figure 5. Factors influencing logistics systems that consequently drives change in the supply chain (Soruce: own figure)

Supply chain design decisions could be decentralized, meaning that managers at each facility make decisions, or centralized, meaning that the decisions are coordinated across the facilities (Meixell & Gargeya 2005). But most importantly, researchers argue that decisions should be data-driven, meaning backed up by data to ensure quality and reliability of the decision (Lu, Yan, Han & Zhang 2019). In addition, design decisions should be aligned with the company's supply chain strategy, otherwise decisions could enhance sub-optimization (Meixell & Gargeya 2005; Rushton, Croucher & Baker 2022). Traditionally, managers focus on cost reduction as the main parameters when doing changes, but supply chains rely on multiple attributes in relation to performance (Meixell & Gargeya 2005). Performance is also measured in terms of reliability, responsiveness, flexibility and assets, which should be taken into consideration when changing processes in the supply chain. Since logistics system does not apply into the model of "one-size-fits-all", the strategies of designing and redesigning a supply chain need to be adapted to the characteristics of each industry.

Rushton, Croucher and Baker (2022) suggest an approach when changing processes in the supply chain, presented in figure 6. The first step is to *identify key processes* for design or redesign where it is important to include representatives from all functions involved in the process. In this step it is beneficial to benchmark with competitors as well. The next step is to *map the main elements* of each process with the purpose of understanding what the process is about, what it is trying to achieve, main problems, and indicate on potential improvements. Thereafter, a *detailed flow mapping* should be done. In this step, the process is studied in detail to identify the workflow and affected departments, this could be time consuming. When this is done, *opportunities for improvement* can be identified. This is most commonly done by a senior management team with representatives from all the affected departments. The team should find appropriate *measurements* and complement the mapping activities. Lastly, *feasible solutions*

should be identified to agree on the change and thereafter *implement the change* when an agreement has been reached. In addition, measurements should be put in place to monitor the process in the future.

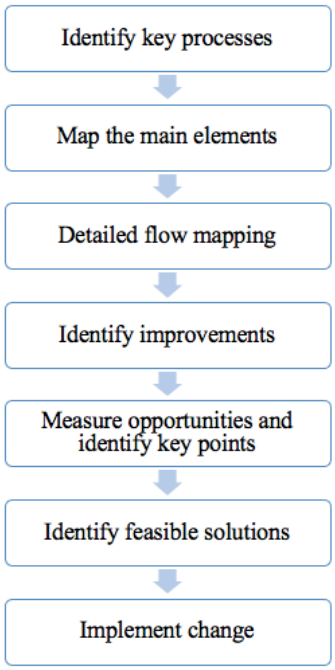


Figure 6. Approach to process design or redesign (Source: Rushton, Croucher & Baker 2022).

3.2 Considerations in Supply Chain Change Projects

The goal of becoming a data-driven organization is a topic that takes up a lot of space in most companies and is driven by many different considerations and parameters, also when it comes to the transportation and logistics industry. It has for many years been a dominant theme driven by technological development and the vision of gaining competitive advantage through data and insight (Wanke & Zinn 2004). Themes like big data, predictive analytics, machine learning and artificial intelligence are often thrown around and screw up ambitions - and rightly so (Prasad & Sounderpandian 2003). Organizations have become brilliant at collecting data and obviously organizations must aim to use that data to the benefit of the organization (Brinch 2018).

Additionally, when looking into considerations on supply chain change project for the purpose of becoming data driven, the different parameters of importance are typically in the form of either being quantifiable or non-quantifiable parameters. In general, quantifiable parameters are defined by the functionalities of being measured, countable and expressed in the form of numbers, while the non-quantifiable parameters are with the functionalities of being conceptual and descriptive (Watson et al. 2013). From those definitions, the quantifiable parameters are in nature a directly driver for data driven decisions and of high value for data driven decision-making (Sanders 2016). However, the non-quantifiable measures are still in need for being in scope as considerations relative to the quantifiable parameters, as the supply chain industry is not static and within a constantly changing environment. Hence, a supply chain change project decision must consider both quantifiable and non-quantifiable parameters, in order to evaluate the full picture of which the change is a part (Watson et al. 2013).

Historically, the transport industry has been lagging behind when it comes to having change projects on digitalization, and heavy logistics is certainly no exception. But also, in this industry today, many operators are working on becoming data driven and understanding the parameters which will lead them to the goal (Möller et al. 2020). All driven by ability to have proper use of data which provides greater success in acquiring and retaining customers and becoming profitable. However, there is often a long way to go to become a data-driven organization. One has to be aware of both the considerations, the parameters of importance and just starting the journey can often be easier said than done (Schoenherr & Speier-Pero 2015).

Optimizing supply chains is almost always a change project. When things change, the company's supply chain is quickly named as a crucial factor in how the crisis unfolds and the consequences are mitigated. The solution catalogue is usually of considerable size - and contains everything from the introduction of new technology or a new IT system to train employees and resuming work on the supply chain strategy (Schoenherr & Speier-Pero 2015). Hence, generally the background for the projects is usually that companies, for one or more reasons, want to improve a number of conditions in the supply chain. Better delivery capacity, less inventory, fewer resources to complete the work are just some of the motivations that can lie in a management decision to initiate an optimization project (Wanke & Zinn 2004). But a basic precondition for fulfilling the management's ambitions is that the employees have the necessary competencies. When an organization start to adopt new business models and make investments in data and analysis work, it is often the culture that represents the biggest challenge (Fassoula 2006). This is, in all probability, also why the transport and logistics industry has long been lagging behind when it comes to working with data. It has always been the custom and culture that it was the human relations that were the driving force behind the way the business was run, and working with data was therefore not a necessity (Möller et al. 2020). But it is a necessity today, and therefore an essential prerequisite and parameter to consider for success to inspire an overall vision across the organization (Prasad & Sounderpandian 2003). It is therefore of importance to define a strategy that replace the "old-fashioned culture" and to state the importance of using data in the parameters and do some thought through considerations of how to approach the change project in a cultural setting, driving a change project with data (Wanke & Zinn 2004). Basically, there are two parameters to a change process that should be considered when doing decisions on change projects. Two parameters that must go hand in hand and support each other if the mission is to succeed. One parameter is the structural business changes that are desired. The second parameter is the changes that employees must go through, and which must create a changed behavior in a new process to support the desired business goals (Schoenherr & Speier-Pero 2015).

A more specific yet complex parameter within the structural parameters, which is often considered doing change projects in supply chain is the financials involved, especially for the supply chain managers. Where the parameter of importance a few years ago was "to streamline the supply chain", the requirement and a leading parameter today is optimization from both an operational and financial point of view. In other words, an importance for deep financial insight with the supply chain manager, or at least a close collaboration with the financial area to ensure this insight (Cohen & Roussel 2013). Thus, many leaders today are faced with a number of simultaneous questions and decisions like: *"where should we place the next new factory to get the best possible return on invested capital?", "who will own buildings, machines and other equipment?", "should we source or keep production internally when the factor costs change all the time?", "what value has an improved delivery capacity? "Is it worth improving this?",* etc. Which all for the supply chain managers are parameters that somehow can be linked to costs (Wanke & Zinn 2004). Hence, the financial cost parameters are of complex considerations

when doing change projects, as costs are related to a magnificent amount of activities in a supply chain. The solution is obviously to do calculations on it, but often the right basis is lacking in the form of reliable historical data, supply chain price lists and supply chain cost drivers. Supply chain cost drivers are parameters that have a large and direct impact on the company's supply chain cost level. In many cases, they are only partially mapped, and often they are not generally accepted (Madani & Rasti-Barzoki 2017). Hence, organizations must consider how to involve all relevant cost drivers in the parameters, in order to have a thorough picture for the costs of the change project.

3.3 Parameters in the Supply Chain Network

Existing literature claims that business decisions defining the most efficient production and distribution system is complex and rely on several parameters. Rushton, Croucher and Baker (2022) suggests that numerical tables of data need to be in place to understand the implication of different decisions. Different parameters that should be taken into consideration when reconfiguration the supply chains are current and future customer location and demand, facility throughput, primary transport costs (fixed and variable), local delivery costs (fixed and variable), and inventory holding costs (Rushton, Croucher & Baker 2022). According to Miltenburg (2005), each producing factory in a company contributes with six strategic parameters: cost, quality, delivery time and delivery time reliability, performance, flexibility, and innovativeness. For production in particular, Lefeber (2012) and Vazan et al. (2019) states that the main KPIs are throughput (number of items per unit time), flow time (the time an item is in the manufacturing system) and work in progress (the total number of items in the system), whereas the throughput should be high and flow time low.

Lanza et al. (2019) proposes a framework that summarizes important aspects of designing and operating global production networks. They state that cost factors, market development, logistics, people and culture, legal factors, and political factors are influencing parameters that affect decision-making in the global production network. Cost factors can be broken down into labor costs, capital costs, material costs, and energy costs, where labor costs often represent the greatest share of costs for manufacturing companies (Lanza et al. 2019). Logistics and distribution represent a central part of costs as well and could be divided into transportation and inventory costs. Except costs, lead times and delivery reliability pose a significant impact on the network footprint (Lanza et al. 2019). In terms of people and culture, there are several differences such as language and mentality but also competence levels in different countries which may affect the decision-making. Considering legal and political factors, aspects such as legal systems, level of corruption, taxes, wages, and environmental regulations could also influence companies in their decision making of their production and distribution network (Lanza et al. 2019).

In general, financial factors are most commonly mentioned as a parameter in relation to decision making in the supply chain network. Váncza (2016) mention financial factors like taxes, duties, exchange rates, transfer prices, and local investments, as factors influencing the network configuration. Melo et al. (2009) states parameters such as return rate, resource utilization, service level, cycle time, flexibility, robustness, and sustainability measures as influencing factors of supply chain decision making.

Govindan, Fattahi and Keyvanshokooh (2017) claim that several supply chain network design parameters have inherent uncertainty. Some of the most common parameters in designing logistics network are demand, cost of activities (transportation, production etc.), capacity of facilities and transportation links, capacity for producing products, transportation time through

entities in the network, environmental parameters, and social parameters (Govindan, Fattahi & Keyvanshokooh 2017). According to Ferdows (2018), business decisions rely on parameters such as demand, production processes (automation, labor, scale, flexibility, reliability, technology), products (complexity and design), and location of production sites including costs of production factors, local laws, tax regimes and regulations.

Generally looking at different references, it is clear that many different parameters are of interest when doing changes in a supply chain, and these parameters are typically depended on what kind of change project there is to be rolled out in the supply chain network. The identified parameters from the literature review are summarized in table 3.

Table 3. Influencing parameters in supply chain networks

References	Segment	Parameters
Govindan, Fattahi & Keyvanshokooh (2017), Lanza et al. (2019), Miltenburg (2005), Rushton, Croucher & Baker (2022), Wanke & Zinn (2004).	Cost	Labor, inventory, material, production, energy, primary transport costs (fixed and variable), local delivery (fixed and variable), inventory holding, capital
Ferdows (2018) Govindan, Fattahi & Keyvanshokooh (2017) Lefeber (2012), Melo et al. (2009), Prasad & Sounderpandian (2003), Rushton, Croucher & Baker (2022), Vazan et al. (2019), Wanke & Zinn (2004).	Production	Utilization, cycle-time, throughput, changeover time, quality, flow time, work in progress, raw materials, value of materials, complexity of materials, level of automation, flexibility, products (complexity and design), capacity
Ferdows (2018), Govindan, Fattahi & Keyvanshokooh (2017), Melo et al. (2009), Miltenburg (2005), Rushton, Croucher & Baker (2022). Wanke & Zinn (2004)	Distribution & Logistics	Delivery time, delivery time reliability, geographical location (current & future), demand, service level, return rate, fill rate, lead time flexibility, resource utilization, location of production sites, capacity, transportation links, robustness
Govindan, Fattahi & Keyvanshokooh (2017), Wanke & Zinn (2004).	Sustainability	Emissions (CO2), people (health, education etc.), regulations, agreements, treaties
Ferdows (2018), Govindan, Fattahi & Keyvanshokooh (2017), Lanza et al. (2019), Prasad & Sounderpandian (2003), Váncza (2016), Wanke & Zinn (2004).	Legal & Political	Local laws, tax regimes and regulations, level of corruption, wages, exchange rates, transfer prices
Lanza et al. (2019), Prasad & Sounderpandian (2003), Váncza (2016).	Country	Endowment factors, cultural factors (people), arbitrage & leverage, government incentives, competence levels, different language and mentality

3.4 Compiling the Theory into a Conceptual Framework

Mapping the concept and developing a conceptual framework based on the literature review is useful to understand theory, concepts in the area, and the relationships between them (Rowley & Slack 2004). After studying literature on the subject area, a conceptual framework could be developed, presented in figure 7. The identified parameters, based on the literature review, have been divided into internal and external parameters. The internal parameters are categorized into strategic, operational, and cost parameters. The strategic category represents parameters that affect the structure of the supply chain network. The operational category covers parameters that act as variables when running the supply chain activities. Costs stands as an individual set of parameters since it is a comprehensive category that is most frequently mentioned in the literature. The external parameters represent factors that affect the business externally such as sustainability, legal and political parameters, and country specific parameters.

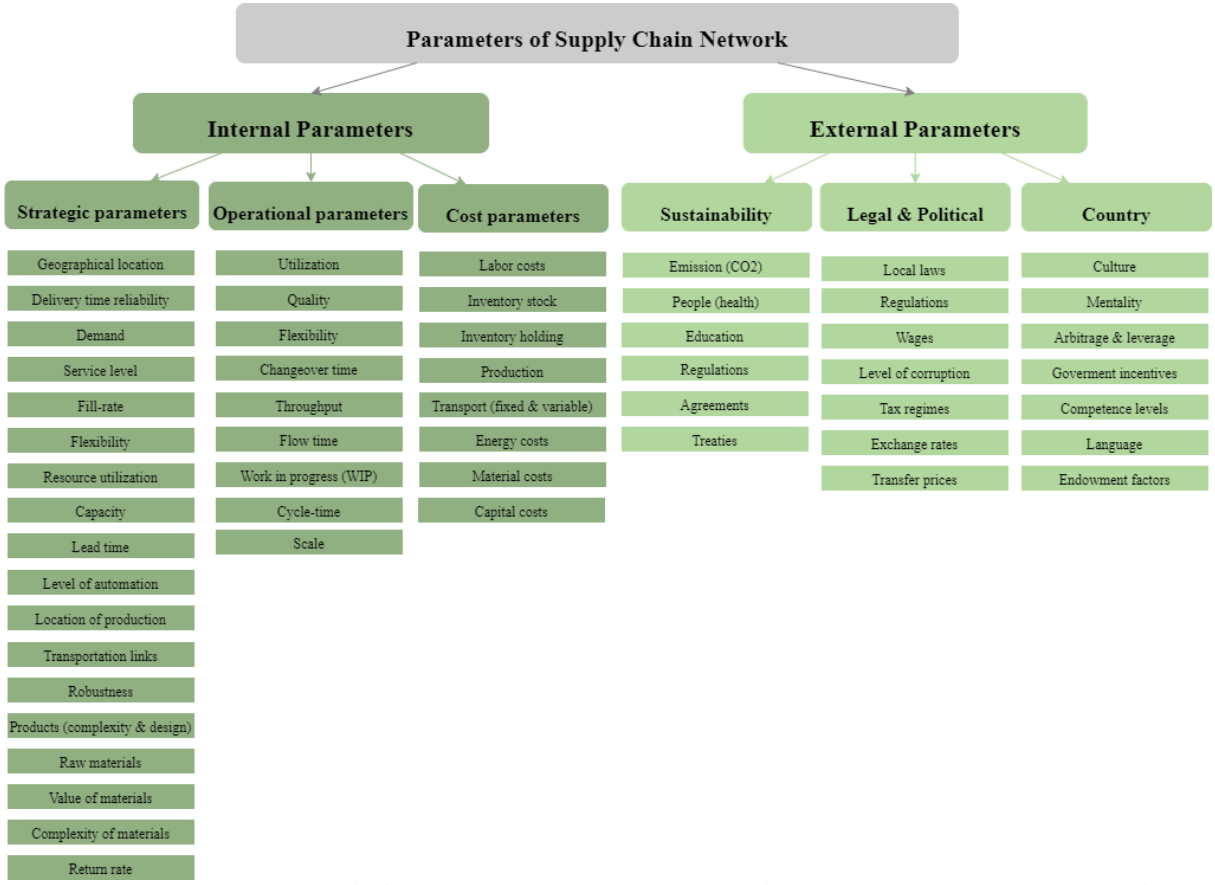


Figure 7. A Conceptual Framework of parameters in the supply chain network based on the literature (Source: own figure)

As seen in figure 7, flexibility is both a strategic and operational parameter. Flexibility is categorized as a strategic parameter referring to the flexibility of taking decisions and for example moving capacity and resources. Flexibility as an operational parameter, is related to production aspects such as the flexibility of machines producing several different products.

4. Empirical Data

This chapter consists of information about Lindab's supply chain network followed by the empirical data collected through interviews with Lindab employees. The supply chain map is presented with the purpose of giving the reader an understanding of how Lindab's supply chain network is designed today. The interview data gives an understanding for change projects and important parameters in the supply chain network.

4.1 Supply Chain Map

Lindab as an organization have different facilities all over Europe. The process of material most commonly starts at Lindab Steel located in Grevie who provide Group Centrals (GC), Domestic Centrals (DC), and Domestic Locals (DL) with material. External suppliers also provide GCs, DCs, and DLs with products. Some sites could have more than one role. For example, the site in Manchester is acting both as a DC and a DL, which includes both warehousing and distribution, but it also acts as a sales company where customers physically enter and buys products. To facilitate the understanding of the supply chain network, a simplified version is presented in figure 8. The sites are located in different countries in Europe which is presented in the supply chain network with the international recognized country code, e.g., SE is the two-letter abbreviation country code for Sweden.

There are six sites categorized as GCs, these focus on production, often advanced and highly automated which require high competence, but they also act as central warehouses. The main production sites are in Grevie, Sweden and Prague (Karlovarská), Czech Republic. The production level at GCs is different from DCs and DLs. In GCs, dense and small products are produced since these are possible to distribute in an efficient way. The distribution from GCs is mainly done to other Lindab sites. For example, deliveries to Domestic Centrals occur daily. However, deliveries are also made directly to customers. Products from Lindab Steel, Lindab Profile, and Lindab Ventilation are mixed and evenly distributed on trucks to achieve higher fill-rate, both concerning weight and volume.

DCs are grouped into four sales regions, sales region northern Europe (SRNE), sales region west Europe (SRWE), sales region east Europe (SREE), and sales region mid Europe (SRME). These sites focus on warehousing and production, but the production is less automated compared to Group Centrals. These sites are located closer to the market and produce larger products in order to reduce the transport distance for these products. From the DCs, products are distributed both to DLs and external customers.

The sites located closest to the customers are called Domestic Local. These sites are less automated compared to GCs and DLs. The focus of DLs is on production of ducts, but they also act as local warehouses. Since the sites categorized as DL deliver to customers, products are stocked here to facilitate short lead times to customers.

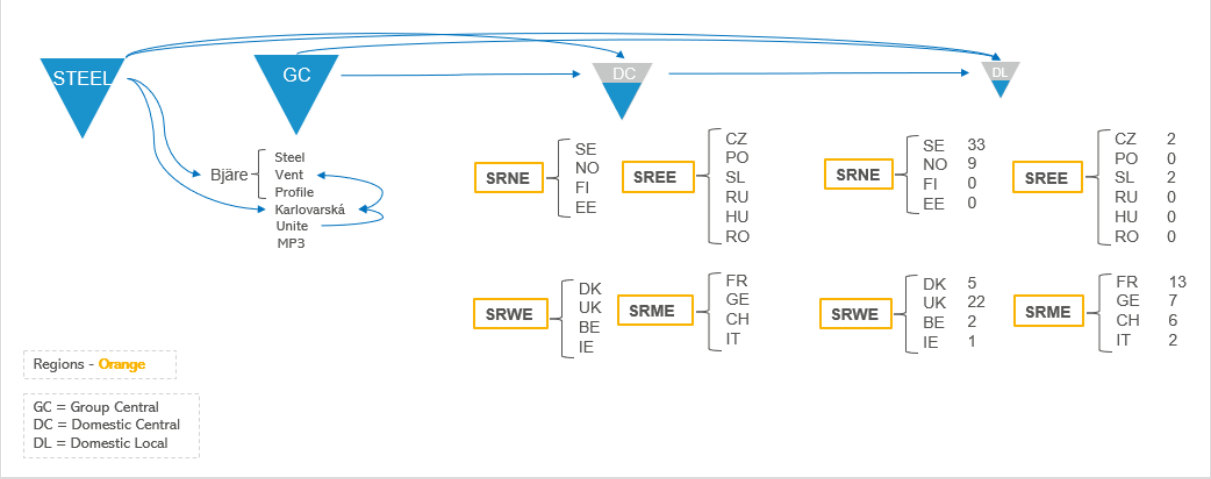


Figure 8. Lindab's Supply Chain Network

To exemplify the flow of goods in the supply chain, different flows of Bends are described (the Bend is visualized in figure 9). The different exemplified flows of Bends are presented in figure 10. Firstly, the steel is supplied from external suppliers which arrives to the harbor in Halmstad and then shipped by truck to Lindab Steel in Grevie. When Lindab Steel has processed the steel, it is shipped to Lindab Ventilation's central production (the Group Central) also located in Grevie. The plant in Grevie, produce either finished products of Bends which means that all parts are assembled including rubber gaskets (which are supplied from Poland), or they only produce half bends which means that the parts are not assembled but shipped in half to be assembled at the production site in Prague.

Figure 9. Bend

Regarding the finished products of Bends, they are then shipped to another Lindab hub, for example in Jönköping (Domestic Local), Manchester (Domestic Central and Domestic Local) or Hvidovre (Domestic Local), which also is defined as a sales company since this is from where the products are shipped to customers. The customer could also pick up the product themselves at the different hubs.

When the Bends are shipped in half (semi-finished products) to the Group Central in Prague, the product is first put together in Prague and thereafter shipped to Pavlov (Domestic Central) who then sells and sends the finished product to customers.

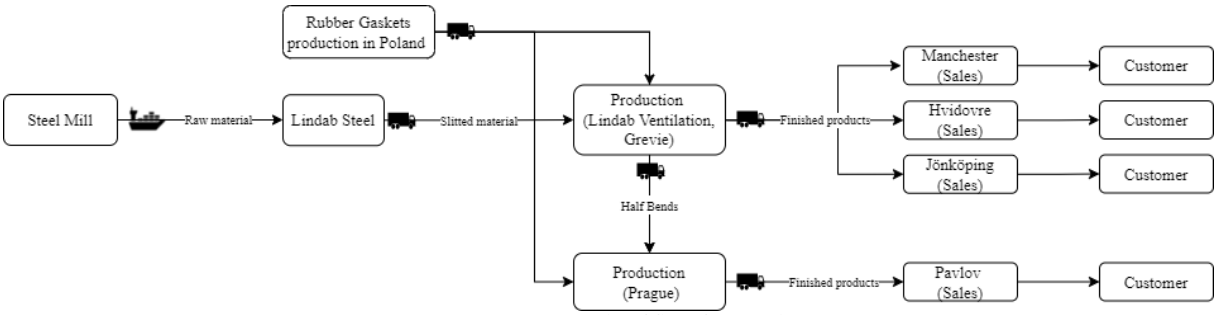


Figure 10. Example of flow for Bends

4.2 Interview Data

This chapter includes the case study interviews presented in table 4. The interviewees are referred to as Candidates due to confidential reasons. The interview guide used for conducting the interviews is shown in appendix 1.

Table 4. Overview of case study interviews

Interviewee	Role	Date
Candidate A	Manager of Group Production Development and Operations	2022-01-25
Candidate B	Strategic Product Manager	2022-02-01
Candidate C	Senior Strategic Sourcing Manager Freight	2022-02-02
Candidate D	Logistics Developer	2022-02-04
Candidate E	Logistics Developer	2022-02-07
Candidate F	Operational Director	2022-02-07
Candidate G	Inventory Manager	2022-02-07
Candidate H	Management Director	2022-02-09
Candidate I	Regional Operations Manager	2022-02-09
Candidate J	Managing Director	2022-02-10
Candidate K	Regional Operations Manager	2022-02-10
Candidate L	Sales Region Manager	2022-02-14
Candidate M	Industrial Manager	2022-02-14
Candidate N	Regional Director	2022-02-17
Candidate O	Logistics Manager	2022-02-21
Candidate P	Managing Director	2022-03-04

Candidate A - Manager of Group Production Development and Operations

Candidate A is involved in answering the question "where to produce what". Accordingly, a lot of effort is put into investigating the change of moving production from central units to local and regional units. The department is constantly involved in changes in their production network regarding production set-up, new machines, faster and more efficient machines, and building new capacity and competence at local and regional units. Candidate A states that several important investments of automation have been done in Sweden, Czech Republic, and Denmark, while in countries like Estonia, the United Kingdom, and France, they are currently working on building local competence and production.

According to Candidate A, they need to set a process to decide on if it is a good idea to invest in local units and move volume. In historical changes, they have done simple calculations of transportation costs and focusing on comparing direct costs at the central unit vs. local unit. But the complexity of making changes in the production network involves several parameters that has gained a greater importance and needs to be in included in the decision-making process when doing a change in the production network.

Candidate A highlights the importance of parameters such as overhead costs, social- and environmental sustainability, cost structures in different countries, fill rate in trucks, utilization of the production (machines), and utilization of an investment. Candidate A explains that the cost structure for workers in different countries has changed the recent years. The difference in salary between former low-cost countries like Czech Republic, and high-cost countries like the UK, is much smaller than before. This has made the cost structures in different countries an important parameter when making changes. Regarding transportation, Candidate A points out the importance of the parameters cost and volume (fill rate) of a truck from point A to B. Additionally, questions like *How will the fill rate be affected when moving production? How many shipments will be done each week?* and *How will the price be affected?* are interesting when identifying important parameters. In the context of Lindab and the production and distribution of different types and dimensions of products, especially considering products of large dimensions but light weight, it could be complicated to make the transportation efficient. According to Candidate A, the arrangement of machines and automations at local units needs to be considered to find the best set-up. Candidate A further states that the utilization of production or an investment is an important parameter to consider. For example, when a machine is set-up to utilize three shifts of work at one unit, off-loading that machine by moving production will affect local earnings and total costs. Another parameter discussed by Candidate A was growth. Depending on growth in a certain region, the capacity needs to be adapted accordingly.

In general, Candidate A highlights that you need to find the best solution for Lindab as a whole which involves several parameters and trade-offs, but the total cost should be one of the main parameters. Additionally, they need to have a lot of data to take the right decision since more data makes them more mature and enables them to do complicated calculations to facilitate the right decision. In order to take the most appropriate decisions, Candidate A summarize that all affected division should be involved in the change process. In particular, the local management team and local technicians to verify data for direct costs and volumes.

Candidate B – Strategic Product Manager

Candidate B describe the responsibilities as product management, IT solutions, innovation of products, research development, sourcing of traded goods, and lastly accessories for production, hence products that Lindab do not produce themselves, but products that are needed to keep production running. The department is described as an independent unit making their own decisions, but it was also highlighted doing the interview, that the department is highly influenced from decisions made in the department of logistics in different parameters.

The products produced in house by Lindab are covering ventilation products, all Lindab's duct products, and in general their indoor climate systems (ICS). Additional to having responsibilities for the products, the department also have a consulting role for designing suitable products to their customers. Meaning essentially collaboration with customers, where Lindab act as the helping part.

For the department, Candidate B describe the overall goals as different parameters, involving GP1 (gross profit), sustainable sourcing, backlog on IT solutions and customer consultancy on design. The GP1 essentially is a goal of having projects which are described to be green in the parameters of time, resources and budget. The target is fixed, and the goals are monitored and measured once a month. When having a benchmark equal to or more than the target, the department consider the project to be of good business and quality. Secondly, sustainable sourcing as a goal means that all collaborative parties should be assessed in risk countries and agree to sign documentation of ethics, typically referred to as "code of conduct", hence an agreement of ethics on both business and people. Third, Candidate B describe the goal of having a maximum of three months of backlogs for IT solutions as a target and goal. Additionally, it is emphasized as a goal to deliver great consultancy and quality when helping customers with designing products, however not targeted with a specific quantifier, as it is a qualitative parameter.
Even though the abovementioned goals are considered overall to the department, Candidate B highlight the differentiation in goals for different teams within this department, hence it is depended on the tasks different teams conduct within the department.

When discussing changes, multiple relevant projects were described both already conducted and projects planned to be conducted in the future. Already conducted was the acquisition of a third-party certification from Eurovent securing that the different production sites deliver a certain degree of quality no matter the location of the production site. This certificate is covering all Lindab's 53 production sites all around Europe, though only 8 production sites are investigated per year, hence it is a constant ongoing process. The acquisition of this certificate has added a great amount of flexibility as production then is able to be moved around in accordance to changes in capacity without compromising the quality of the produced goods. Additionally, Candidate B describes a change in how the strategic product development is involved with the department of production when making decisions. Hence, the collaboration and involvement are conducted much earlier than done in the past, essentially getting common understanding of where and how to produce along with which materials to use to efficient sustainability parameters.

For future changes in the pipeline, a larger one is moving more of the production to local production when it is beneficial. Typically, in the reference to the factor of, the bigger the product the more beneficial it is to have it locally, due to transportation especially in relation to

minimizing the amount of transported air/ utilization of transport capacity. To help make decisions in this matter in the future, Candidate B emphasized the most important parameters to be capacity, salary, cost, and sustainability, but without compromising the parameter of quality. As of today, there is no automatic system weighing in these parameters for making the decisions in such changes. Another future change that is likely to happen is Lindab buying or acquiring additional companies, but in unknown locations as of now. The parameter driving this as a change is described to be either, to buy market share, cover wider spots, or to acquire knowledge and product assortment e.g., IT, apps, sensors, or other relevant technology. In connection to these parameters, are also considerations around the flow of the new companies, like how shall products, resources, inventory stock and logistics be covered at this new location in order to meet the demand with the same quality as already established sites.

Lastly, when asked to summarize parameters of importance, Candidate B highlights the following parameters: quick and reliable delivery, being close to customers, lead time, easy to produce, efficient production, efficient logistics systems, capacity, costs (as low as possible), quality of materials, volume/utilization and lastly sustainability.

Candidate C – Senior Strategic Sourcing Manager Freight

Candidate C has the main responsibility for purchasing freight, the outgoing deliveries from Grevie, Sweden and Prague, Czech Republic, and writing agreements with freight companies. Candidate C is also involved in several logistics projects. When discussing change projects, Candidate C exemplifies the activity of weekly deliveries from Sweden to Norway. Historically, they have done three weekly deliveries from Sweden to Norway, and the reason behind this is that they are not aware of when the customers will arrive to the branches and therefore, they need to build stock. When they reduced the weekly deliveries, they saved significantly on freight costs but increased the lead time. Candidate A highlights the importance of balancing freight costs and lead time, but also including the environmental aspect when doing changes.

According to Candidate C, motivating changes in the organization is difficult and complex since they do not have a tool that can visualize or exemplify how different parameters will be affected by a change. Furthermore, Candidate C explains that the holistic view in the organization is missing throughout the different departments. Consequently, departments take decisions or manage activities based on their assumptions and feeling. For example, historically they had trucks in the UK making deliveries with a fill rate below 50% because salespersons accepted deliveries that were outside the regular agreed delivery days. When this issue was communicated and deliveries were not allowed on days outside the agreed delivery days, the fill rate increased significantly. Regarding, future changes in the network, Candidate C points out projects such as how to distribute most efficiently in terms of volume and capacity, providing accurate forecasts in sales and production, investigating when it is the best day to ship items, and if deliveries from several countries could be merged to achieve more efficient transports.

When discussing important parameters, Candidate C highlights fill rate, costs, freight costs in different countries, delivery reliability, environmental issues, and capacity. The fill rate is important and affects both costs and environmental factors. Candidate C explains that the fill rate is a constant issue related to how much customers buy and customer expectations of fast deliveries which affect how long a truck can wait to be fully loaded. How different items are loaded together in the truck and what kind of tertiary package is used are also contributing

factors that affect the fill rate. Regarding capacity, Candidate C discuss the current lack of truck drivers which affect the capacity of available trucks. There is a mismatch between Lindab's increasing volumes and decrease of available trucks. Additionally, Candidate C explains that the European Union changed the regulations of commercial road transport. The change, called mobility package, means that truck drivers need to go back to their home country every third week. Candidate C discuss that this regulation affects route planning and the management of efficient transports.

Candidate D – Logistics Developer

Candidate D is working with logistics development at Lindab, with the responsibilities and work tasks covering the transport concept, warehouse field, inventory management concept and project assistance in a technical aspect. Through the interview, Candidate D highlighted different change projects in which he is doing assistance on. Firstly, a project covering the big need for accurate picking of goods in warehouses. In this connection it was emphasized as an ongoing change project with a continuous need of learning on new technologies like Power BI and data collection. Secondly, the project of understanding the inventory concept with considerations of, how to approach it, understanding what is in stock, the development, and the use of the Lics system (Lindab inventory control system) which is integrated at Lindab. Lics is the information system which generate the parameters of interest, and have the ability to calculate and evaluate data, an important asset for data visibility. Hence highlights the importance of having useful and data supportive information systems.

When discussing the parameters driving the different change projects, Candidate D describes how the transport is done through planning a year ahead with the parameters of total savings and avoidance of extra costs. In connection to this, different considerations are discussed. Considerations like flexibility of moving around items to split costs, stock handling with the focus of determine what items that haven't been used in a year, items not selling as expected and general cleaning of items in relation to demand. When looking specifically at the warehouse field, the driving parameter is defined as transaction per employee in a line in the system, hence on a line level not on a picking or transport level. The data for this parameter is supported by Power BI reports from the Lics system.

Additionally, Candidate D highlighted general considerations when doing change projects. Including, total sales, transportation costs, fill ratio of trucks, cubic meter prices on materials, and transportation frequency. These parameters are evaluated and looked at every month in relation to doing optimum ongoing changes to different projects. Though these monthly follow ups and evaluation, the improvement area of interest is often to have more items in stock in order to fill more trucks, hence efficient the fill ratio. Moreover, looking at general parameters, Candidate D highlights the importance of transparency on the data and numbers involved in different change projects. Hence, transparency which will enable all involved parties to evaluate and influence parameters of which should be considered, and lastly to easily visualize the changes along with them happening.

Lastly, the parameters of sustainability were briefly discussed. Candidate D describes how when doing changes inside the warehouse, sustainability is in term not of high considerations, besides the fact of trying to save jobs at warehouse. Hence, changes must not lead to reduction in employees if can be avoided, which is argued to be social sustainability.

When asked about future changes affecting his position of work, Candidate D highlighted the likely project of implementing the Lindab Inventory system in a new location proportional to Lindab buying up new companies. For this matter Candidate D described the following parameters and considerations as drivers for the project: how many items are needed, how much is already on hand, sales, building stock, picking, system interface and stock policies on items (MTS, MTO etc.). Additionally, to implement the inventory concept, Candidate D emphasizes the need for some kind of central control of the inventory, all influencing parties have the data and corresponding database, these must be linked to the same systems in order to fully succeed in implementing the inventory concept.

Candidate E – Logistics Developer Internal Logistics

Candidate E has the responsibility of developing internal logistics which involves educating employees to use Lindab systems. The aim is to educate people to use their logistics systems correctly so that their systems can support what they are doing in reality or vice versa. Regarding goals in this function, Candidate E explains that they are project-specific, but a general goal is to fulfill the agreement based on how the system is working. In these agreements, there are some typical guidelines in terms of costs, time used, and number of employees. Candidate E highlights that the most difficult task is to change people, i.e., change management, and that change projects takes time.

When discussing parameters, Candidate E explains that these are dependent on a specific project but indicates that the better, faster, and cheaper a certain project can be accomplished, the better. Candidate E mention transaction per hour per employee as a specific parameter meaning that doing more transactions at the same time without using more resources qualifies as a success. In addition, education among employees counts as an important parameter. Since Lindab continuously buy different companies, the education plays a vital role to apply the same mindset throughout the company. However, the most important parameter discussed by Candidate E is customer satisfaction. Depending on customer requirements, Lindab aim to work accordingly to have a high service degree in relation to their customers. For example, the customers require a Just-in-Time delivery while Lindab would benefit from having only one delivery per week. Requirements like this could be fulfilled as long as it is balanced with the total cost. In general, customer requirements should be fulfilled without compromising the revenue although it could mean additional work for internal logistics like handling or transportation.

Candidate F - Operations Director

Candidate F has the responsibility for the central operations revolving the ventilation operations at Lindab. Within the typical tasks described to be, define and follow-up on relevant KPIs both financial and operational and report to the CEO and define and execute on investment plans on 3-5 years horizon for Ventilation Systems business area. These tasks are subject to a defined set of parameters which Candidate F highlights to be, safety, delivery precisions and cost control, where safety is the number one parameter.

The procedures for the safety parameter, is that all meetings start with a status in safety on work procedures, how many incidents have been reported and how many unsafe situations have been reported. Hence, measurements on data, in order to do prevention on future unsafe situations, to increase awareness, focus on the area and to have transparency of all reported unsafe situations. All of which is scoped down to a parameter defining the number of incidents oppose

to the number of hours, which is then reported every month. In connection to this, Candidate F describes how it in the past was the number one priority to satisfy the customers, that parameters are now trying to be turned to have safety as the number one priority. As safety is a parameter highly bounded to culture and people behavior, Candidate F acknowledged that this is a parameter that constantly develops, and that differs among different geographical locations due to cultural differences.

Delivery precision is the parameter of how good the operations are at delivering to the agreements made with customers. This is evaluated by constant measurements of actual delivery time. Hence, if goods are delivered on the agreed day, the delivery precision would be equal to 100% on that delivery. Candidate F highlights this parameter to be one of the most critical in use, and as a function of delivery time. In connection to this, Candidate F describes the importance of knowing that the targets for the delivery precision differ for different units, and that items with short lead-time are more difficult to have high target levels on, than items of longer lead-time. As an example, Candidate F, describes how the targets are different between different markets, as an example between the Swedish market and Prague, simply because the units in Prague are subject to a longer delivery time.

Next, Candidate F described the parameter of cost control. Cost control consists of different dimensions which all contribute to the calculation of whether the anticipated costs are in fact fitting the reality, hence the forecasted costs. These dimensions cover follow up on product increases with high frequency, specifically every hour in the production. Though not covering 100% of all production lines, but the majority. That is done by collecting data from the different lines, evaluate and visualize the data for the production manager. Additional to that the availability of items and delivered quality is accessed. The quality is defined in how many good pieces that where produce relative to the whole amount produced, which Candidate F highlights to be a key parameter in which their function follows up on. Hence, the foundation for great performance is the standardization of follow-up on the different parameters. Lastly, looking at the parameters, Candidate F highlights the parameter of capacity utilization, which is a parameter they try to monitor closely. Though not in a scientific manner, they are not calculating number, but rather checking for balance. Hence, is the production over or under-utilized, which is then used to decide to manage lead time up or down to fit the utilization and execute action. Candidate F describes how the utilizations rarely is a perfect match, but typically is indicating either too many or too few orders.

When talking changes, Candidate F described how Lindab have changed covering the last 4 years, as it had been decided to decentralize more of the organization, and how Lindab in the past have been under invested in modernizations and productivity. This change has led to a positively impact on investment plans for the future mainly in production, elimination of unsafe equipment and increase in logistics efficiency. Though the key parameters which were highlighted above where not changed or affected by these past year's changes. Candidate F still highlights how the parameter of having pushed down the responsibilities to the units, have increase the overall performance, as all know what they are accountable for what they are measured on.

Additionally, in relation to future changes, Candidate F describes the change of investing in increasing the capacity with the purpose of optimizing the footprint. Furthermore, the dilemma of where to produce what, with instant evaluation which drives to an optimum solution for a production of a given item, relative to the situation on the market. For this matter Candidate F, describes how the rule of thumb is that it is beneficial to produce items with lower dimensions

centrally and fully automated, while it is beneficial to produce larger dimensions close to the market. The drivers for these changes are especially believed to be parameters of cost pricing involving: material cost (mainly steel), packing of materials (pallets, what makes the goods capable of being transported etc.), labor costs, how many hours is spent on the item, and overhead costs (for every production line), all of which is forming the cost price, and is used for setting the pricing at Lindab. Additionally, external factors will affect the cost price, when calculating price, it can be relative to the labor costs, which is increasing in many of Lindab production sites and also the fact that some locations are under pressure to find workforce.

Moreover, Candidate F discuss the future change of becoming more sustainable, which is believed to bring additional changes to the table at Lindab. One change could be the use of fossil free steel which Lindab is closely following the development on, though not believed to be a change within the nearest future. Generally, Candidate F describes how sustainability factors are likely to be more prioritized in the future. Hence, will drive new change projects, but along within Lindab being able to keep up to the sustainable promises which they make, in order to avoid "greenwashing". In connection to that, Candidate F highlights how the sustainability aspects also have increasing interest from the investors in Lindab, given a certain pressure on Lindab to invest in delivering on this matter.

Additionally, Candidate F believes that Lindab benefits from the increasing standard of indoor living when it comes to climate, hence an external factor that can bring further changes to Lindab. Also, a trend which Lindab follows closely and try to influence by being part of different committees covering the area.

Candidate G – Inventory Manager and Analysis Models Specialist

Candidate G has the main responsibility for inventory management including development of tools and making the inventory more efficient. In addition, Candidate G is involved in several projects to support with data modeling. This is done by enabling and building analysis models to facilitate business analyses to bring insight from data and improve the company. Candidate G explains that availability and days in stock are two of the main key performance measurements. Availability measures the service level from stock to customers, making sure that there is enough inventory. Days in stock represent how much stock they have in relation to sales. Candidate G also mention the importance of reliable data. For example, availability is based on current stock levels, if the stock level is wrong, then reality is not represented in the system and the data becomes unreliable. Therefore, a lot of effort is put on monitoring parameters and improving the quality of data to trust the values in the system.

Discussing change projects, Candidate G highlights that there are several changes regarding the logistics set up. For example, moving production from the central unit in Prague to Germany where a new distribution center is established, or the change of concentrating specialized production into centralized units and move out the other production into local sites. Regarding these kinds of changes, a lot of focus is put on production, optimizing production rates and costs, since its often the production department that drives these changes and their parameters influencing the decisions. In that matter, Candidate G points out that parameters outside production are not as considered when doing these changes. Perspectives and parameters from other parts of the company such as work environment, safety regulations in countries, injuries at different sites, transportation issues, and customer service are some examples of parameters that are missing according to Candidate G. Because of the focus of improving production, the improvement of other factors may pass by.

Parameters often interlink with other division's parameters. Candidate G states that inventory levels are affected by lead time, and lead time creates uncertainty. The uncertainty needs to be covered by safety stock in case of disruptions. Furthermore, Candidate G discuss delivery time and transportation frequency (how often trucks go between certain locations) as parameters that are affected when moving production. Originally, there could have been enough volume to have daily trucks to a certain location, but when moving production, you lose volume between two locations which could lead to less deliveries. If volume is lost on a route, the consequence will either be less filled trucks going to that location or a reduction of transportation frequency which affect the lead time which in turn affect stock.

In addition, Candidate G explain that changes in the production network affect the availability since you put stock on several locations that drives up the stock value, but also the risk of not having stocked up enough when you launch a new facility. Therefore, it is important to make the right decisions at the right time regarding when to make the changes since you need to build up stock to cover the uncertainty of production during the change.

Other important parameters highlighted by Candidate G are delivery performance, customer service, monetary parameters, processes in warehouses, and environmental and social sustainability. The delivery performance is based on either stock availability or where the production is located. Processes in warehouses includes avoidance of inventory discrepancies, sufficient stock levels, and warehouse behaviors. Social and environmental sustainability are of great focus, especially for external companies and shareholders, which influences the business. However, Candidate G explains the difficulty of intangible parameters since they are not as easy to measure as tangible parameters. Consequently, tangible parameters become prioritized since the success of a change is easier visualized in data and numbers. Regarding the environmental sustainability aspect, Candidate G mention parameters mainly in transportation such as the truck fleet, type of fuel, and transportation distances, but also the efficiency of forklift driving in terms of less rubber used, less energy used, and less maintenance.

Candidate H - Management Director

Candidate H is management director at the UK distribution facilities of Lindab and describe the responsibilities of the position to the responsibility for business and customer results and goals. These goals and results consist of meeting customer demands, how static data is used relatively to customers having the nature of not being static, flexibility of the organization, hence making sure the distribution can adapt to changes, and lastly the organizational aspects and the sales numbers.

In the past years, Candidate H highlights changes of health and safety, stock levels, system changes and decentralize to more local points of distribution. Changes which were mainly driven by how customer service can be increased for the customer. Meaning the parameters of delivery precision, lead time and quality of the products delivered. Additional to that, parameters of availability, stock levels, machine efficiency and volume (fill-ratio) also are parameters drivers behind the different change projects. For future importance Candidate H, highlights how data will be of importance to precisely mentor these parameters, with the benefits of increasing customer service even more.

Candidate I – Regional Operations Manager Production

Candidate I is the Managing Director for production at Lindab Ventilation in Grevie. The most important parameters in the position of Candidate I are health and safety at work, delivery performance, customer service which is connected to quality, and productivity. These parameters are target based where productivity should be continuously improved by a fixed percentage and a fixed target in delivery performance should be achieved. Productivity and delivery performance are also connected to stock levels. In order to produce efficiently and delivery on target, they need to have sufficient stock levels. Furthermore, to reach the target in delivery performance, Candidate I mention that they are dependent on other internal and external units that deliver material to their facility. Depending on deliveries to the facility, the target of delivery performance and customer service will not be fulfilled. In addition to that, availability is an important parameter to take into consideration to full fil customers' requirements.

Moreover, Candidate I discuss that the increasing volume is one of the main drivers for change. Lindab has had a growth of approximately 7% per year which has resulted in their facility being fully utilized. In that matter, a new factory will be built to handle the continuous volume increase. Other change projects discussed by Candidate I is the production network set up in Lindab. Several changes have been done regarding where to produce what. For example, duct production has been moved out from central units to local units. The reason behind this is due to environmental and economical purposes. Local production of ducts, which represent a big volume, can reduce transportation costs and thereby the impact on the environment. Candidate I explain that sustainability is an important aspect in the organization, and it is often connected to financial aspects. For example, improving products and reducing the material will result in savings on both money and the environmental impact. However, Candidate I mention that sustainability is a relatively new parameter that needs to gain higher prioritization in the company. Since sustainability is a new parameter, they are not as mature in measuring sustainability in comparison with delivery performance for example.

Candidate J – Managing Director

Candidate J is Managing Director with responsibility of all operations in the Czech Republic related to Lindab Ventilation. In general, the responsibility of producing and supplying all the products to all the other sites in Lindab for different countries.

In the past few years, Candidate J highlights how different change projects have been surrounding investing money in automated solutions, in order to save labor as work force is difficult to find in the region, to increase the efficiency, and lastly, in order to secure the right price for the products produced. On top of that, the department have tried to change the internal responsibilities, essentially moving responsibility down in the different functions, in order to keep the reactions and responsibilities directly to the people who are working on the actual production of which the changes happen.

The general KPI's and parameters working as drivers both in general but especially in change projects are highlighted to be safety, meaning to decrease the number of accidents hence a safer work environment, delivery precision, customer service, lead time, productivity measured on all production lines in the warehouse, quality both internally and externally, delivery performance, and utilization in stock levels.

Additionally, Candidate J highlights how an ongoing change is continuously looking into where to produce what, both in the parameters of what is referred to as a softer parameter, hence labor costs and finding people for workforce. Also, in parameters referred to as hard parameters, meaning the service level, delivery precision, freight costs and cost price.

Moreover, Candidate J discuss how another future change project will be to work with the current capacity issues at the warehouse, space needs to be made available in order to ensure the correct flow of processes, and to balance the plusses and minuses. It is believed that parameters for this change will be to have good information systems, in order to provide the employees with accurate and reliable data. In connection to that, Candidate J describes how implementation of a new ERP will kick start this change project.

Candidate K – Regional Operations Manager Production

Candidate K is the Operations Manager of Production in Haderslev, Denmark. The responsibilities involve activities as manufacturing, purchasing and logistics where logistics means warehousing and transportation. When discussing parameters in the position of Candidate K, cost is mentioned as an important parameter when doing investments, changing the flow, and changing the logistics layout. In addition, product quality is always an important parameter. However, Candidate K highlights the service level as the most important parameter which include short lead times and high delivery precisions to customers. The service level must be prioritized to achieve high customer satisfaction, but it should be balanced with costs and earnings.

Historically, Candidate K explain that direct labor costs for a product has been the most important parameter to look into when doing changes. Material costs should be equal at all sites; therefore, this is not taken into consideration. When doing changes for specific product families, for example moving production for the product family, freight costs, labor costs, and handling costs are calculated. Since the Czech Republic is a former low-cost country, Candidate K mention that production has been located there due to low labor costs. But Candidate K explain that their central production in Prague is over-utilized and that is one of the reasons for changing the location for production of some product families. In addition, due to the small difference in labor costs between countries in Lindab's supply chain network today, it is crucial to take the right decision on where to produce what based on several important parameters and not only labor costs.

In the future, Candidate K discuss sustainability as an important parameter to take into consideration. Candidate K exemplifies how decisions could be made to save costs but when parameters regarding sustainability, such as CO_2 emissions and km of transport, are calculated, the savings in costs could later be outweighed by sustainability aspects. To cope with sustainability, Candidate K mention that the company will be supported by sustainability experts to help the organization act on the issue.

Candidate L - Sales Region Manager

Candidate L is sales region manager in the western Europe region, covering the countries of United Kingdom, Ireland, Denmark and the Netherlands. The main functions of which Candidate L is responsible for is looking for accusation of companies, trying to buy new companies, investigating how to become more automated and digitalized from investments an acquiring of market share.

As an example, Candidate L have been a part of hiring sustainability specialists, who of which investigate Lindab in order to get better knowledge of how to become more sustainable. When talking about goals of importance from the perspective of Candidate L, it is highlighted that sustainability is the license to operate, the strategy and continually push for changes to become more sustainable and to be more profitable, have better customers and satisfied employees are the main goals in the perspective of Candidate L.

In relation to KPI's, Candidate L highlights the use of both global and local KPI's. For global KPI's driven from top by the CEO are the KPI's of sales, profitability, cost, revenue and safety at the workplace. These global KPI's are then approached by the local strategies of investment plans for all units up until 2025, plan of contribution to increase capacity, efficiency, and lower costs between employees and functions. On top of that is the continuous goal of developing talent programs internally in order to gain and open all potential possible in each employee.

In relation to changes, Candidate L describes how an increase of branches specifically in the region of UK have contributed to minimization of stock and delivery time, and how these additional branches' return on investment (ROI) have been covered almost by savings generated on freight cost in the entire implementation project of additional branches. Additionally, to the branches, a transport management system has been implemented in order to tell customers up front whether items are available and transparency in case of postponement. All factors of which are drivers to achieve better customer service, both from the aspects of delivering goods home to the customers but also in aspects of the customers who physically come to a Lindab Hub to pick up goods, the type of interactions the customer service is strived to be of best quality.

When talking future changes, Candidate L highlights the projects of implementing a new ERP system, incorporating more robots and co-bots (collaborative robots) in different Lindab processes, through both doing investments, along with accruing new competences and resources. All future projects of which shall contribute to a business growth of 10 % each year, and projects of which shall invest in the future of making Lindab more sustainable. Additionally, Candidate L highlights the importance of remembering the incorporating and aspect of safety first, meaning mediating the importance of caring for the employees for each and every employee at Lindab both mentally and culturally.

All of which these future abovementioned changes shall be driven by the parameters and goals of generating profitable regions that are growing every year, getting more modern, digitalized and automated logistics, and lastly to move Lindab into a more sustainable era.

Candidate M – Industrial Manager

Candidate M is industrial manager in Montluel, France which includes responsibilities in logistics, procurement, and production along with automation projects and industrial development. Important parameters in the position of Candidate M are health and safety, profitability, days in stock, availability, utilization and delivery precision. Where health and safety and EBIT (earnings before interest and tax) are considered the most important.

Considering change projects, Candidate M mention the expansion of the existing facility in Montluel. Since the central unit in Prague is over-utilized, they have invested in a bigger facility in Montluel to be able to produce items normally produced in Prague. This expansion involves

a high degree of new automation, new production lines, and new fittings in the facility. The reason for expanding the facility in Montluel and not Prague is due to parameters such as volume, cubic meter transported, freight costs, shorter lead time to customers, and in general lowering the pressure Prague have today regarding production and logistics.

Furthermore, Candidate M discuss scrap optimization, quality, and price and optimization of packaging as parameters that are of importance when doing change projects. Keeping true to the processes that needs to be done is also an important aspect according to Candidate M. In addition, sustainability is a significant topic that needs to gain greater focus and will contribute to Lindab developing their business. Summarizing the discussion, Candidate M consider customer service, which is connected to volumes and delivery precision, and profitability as the top priorities.

Candidate N – Regional Director

Candidate N is regional manager in sales region northern Europe. The responsibilities include leading managing directors in the region and develop the region sales, the profitability, and the managers. The most important parameters in the position of Candidate N are growth, EBIT, environmental and a safe and happy working environment.

Candidate N explain that automatization of different production lines is an on-going change at Lindab. The main driver for these change projects is to improve the safety for people working in production. Since Lindab handle heavy material, the risk of injuries is high. Therefore, Lindab try to automatize parts of the production to avoid injuries, but also to eliminate boring manual working tasks. In addition, Candidate N state that the benefit of automation is also the possibility to increase the volume produced. Other on-going projects are the acquisition of companies. By acquiring new companies, they introduce new products and a new assortment that they need to adapt to.

In the future, Candidate N state digitalization as a main change. Digitalization will include interactive IT systems, robotics, and new machines that the company need to develop and maintain. This will be a big driver which will require new knowledge and skills. Furthermore, Candidate N discuss the change of the logistics set-up. As of today, Lindab has two central production sites, in Grevie and Prague, that supply the other units. But going forward, Candidate N explain that they need to have a local presence. Setting up local production sites will require decisions of which product families to produce locally vs. centrally in relation to parameters such as costs, transportation, and sustainability.

Moreover, Candidate N explain that by focusing on digitalization, environmental issues, and fossil free steel along with KPIs connected to these areas, Lindab can increase their EBIT and profitability. Another important aspect is the customers. Lindab need to adapt to customer requirements to stay competitive on the market. Flexibility and adaptability are important aspects, meaning not only setting up a system but adapting all the time in relation to customers, acquiring new companies, and being present in building projects in new cities.

Candidate N also explain that Sweden and Denmark are the drivers in Lindab, meaning that other regions are dependent on this region driving the development. Changing something in Sweden will influence other regions to follow the same path. However, Candidate N mention

that changes need to be adapted to each region and that the government have different levels of influence depending on the country.

Candidate O - Logistics Manager

Candidate O is a logistics and sales manager, responsible for the market of Sweden. In short, his responsibility is to have the holistic view of both logistics and sales covering 30 different sites/shops. When asked about the main parameters of his function, Candidate O highlighted that the parameters cover three different areas, inventory management, transportation management and lastly internal logistics management. In connection to those three areas the parameters consist of firstly freight net, meaning how much freight costs there is relative to revenue, the lower the better, and it is measured in two ways, both from the factories to sales, but also from sales to customers. Secondly, is the parameter of fill-rate, which Candidate O considers to be the most important parameter along with availability. Hence, a main goal is to balance fill-rate and availability to never have too much stock or opposite run out of stock. Lastly, the parameter of order lines picked, which is specifically for the areas of internal logistics. Though Candidate O emphasize that it is not a parameter of major focus, as his area of work to process that many transactions in general.

When asked about changes, Candidate O, talks about the decentralization of producing the products as mentioned by several other candidates, and with the main driver of saving freight costs, hence saving money. Hence, Candidate O highlights how freight cost was the main driver, but also flexibility was a parameter, as the ability to be flexible to meet customer requirement, but also that in general moving production locally is driven by the volume of demands from different customers.

On top of that, Candidate O, highlights how they make constant changes especially in transportation, not daily but continually, to make sure they have the right balance between fill-rate and availability, hence not too much or too little goods, a constant change of state. The main parameter and driver for this constant changes, Candidate O describes to be the environment Lindab is in, meaning nothing is ever static, one makes decision of the current state, hence continues change to meet current state.

When asked about parameters which Candidate O consider either over or under prioritized. Candidate O highlighted that he believes that something that is often overlook is the alternative costs, what happens if we do not change this, hence not making a decision also have a cost. Sometimes Lindab is forced to change stuff as competitors do it, meaning this is an external driver form competitors.

For future changes projects Candidate O, describes how the volume is persona based at Lindab, meaning if one is to leave the company, it happens that this person brings the sales volume with them. Hence, a future parameter will be to make sales less persona based. Another change in the future, Candidate O highlights is to optimize inventory control, in terms of the parameters of utilization and availability, hence ensure good quality for this data.

Candidate P – Managing Director

The final interview was conducted with Candidate P who is managing director in sales region mid Europe. Candidate P state that the most prioritized parameters are sustainability, safety, costs and profitability. However, historically, the criterion for making decisions were different.

The main driver for making decisions, for example moving central production to eastern Europe, was because of costs – it was a pure economic business decision. In the past, the salary in Czech Republic was 1/4 compared to central Europe, and this became the main reason for putting the central production in Prague. Today, Candidate P highlights that sustainability and labor issues has gained higher importance but also the political situation in a country. According to Candidate P, the company need to understand the political situation in a country before establishing the business. Furthermore, the business should be ethical, meaning that they don't want to supply, or have production, in countries led by dictators or with bad labor standards.

Candidate P mention that, in general, production should be relocated to emphasize local resources and minimize the supply chain footprint. This will impact the economic situation and reduce the environmental impact like CO_2 emissions. Candidate P highlights that this would not been considered 20 years ago. Sustainability is expensive to cope with, but if the environmental impact is not included in a business decision today, it will not be approved. Candidate P explain that the company has hired supply chain engineers to deal with sustainability issues.

Moreover, Candidate P discuss some specific parameters that are measured and observed in connection to the technology shift. The machinery equipment is measured on energy usage and by that, investments are made on efficient machines to save energy. The electrical components in different facilities are replaced to save on electricity consumption. The heating systems in buildings are also replaced to use more renewable energy. Additionally, they are also changing the truck fleet to use more hybrid and electrical cars. In terms of products, they try to design efficient products to save energy but also to reduce the amount of printed paper connected to the products.

Candidate P mention that there should be a balance between delivering results on a short term and investing in the future. For example, investing in an expensive machine that is more sustainable and safer. Discussing the parameter of safety, it is considered of high importance. Candidate P highlights that safety aspects are considered before profit. The employees are expected to be safe at the workplace. This means that Lindab invest in machines so that working procedures become safer. Safety could be seen as a given circumstance, but safety is not given in every country. Candidate P discuss that humans being involved in a process, trained and equipped, could make mistakes. In terms of education, it is important to educate and maintain the skilled employees, but the aspect of culture could make the willingness to change difficult. Candidate P mention that every employee needs to have the right mindset and adapt to the company culture to be a part of the safety system.

Furthermore, Candidate P highlights the importance of flexibility and adaptability. Since the world is constantly changing, you need to be able to adapt and thereby be flexible. If the company is too slow to adapt, they can lose market share. Candidate P explain that the essence of flexibility is to be able to "step in and out" of a contract or country easily. Contracts should only be signed so that you are able to resign from the contract to not lose more than you can generate. Flexibility is both considered in a long term and short term.

Candidate P also discuss some external parameters. Competitors are considered a driver to develop the company. Competition force Lindab to become better and invest in new machines. Customer behavior is also an important consideration to cope with customer and market requirements.

4.3 Summary of Interviews

In total, 16 interviews were conducted with Lindab employees to gain insight on important parameters in the supply chain network. At the completion of 16 interviews theoretical saturation was achieved, meaning additional interviews were not considered to bring additional findings to the empirical data. Hence, no additional interviews were needed. In table 5 the most important parameters mentioned during the interviews have been summarized and highlighted.

Table 5. Summary of interviews regarding important parameters in the supply chain network

Interviewee	Role	Important Parameters
Candidate A	Manager of Group Production Development and Operations	Overhead costs, social and environmental sustainability, capacity, country specific costs, fill rate, location (local or not) utilization of production and investments, automation, growth, efficient transport.
Candidate B	Strategic Product Manager	Quick and reliable delivery, being close to customers & location, lead time, easy to produce (design & innovative), efficient production, efficient logistics systems, capacity, costs, quality of materials, volume/utilization, demand, inventory sustainability, flexibility.
Candidate C	Senior Strategic Sourcing Manager Freight	Fill rate, costs, freight costs in different countries, lead time, delivery reliability, environmental issues, regulations, capacity.
Candidate D	Logistics Developer	Transportation costs, total sales, information systems flexibility, demand, transaction per employee, stock handling employee, fill rate, cubic meter price on material, transportation frequency, sustainability, inventory.
Candidate E	Logistics Developer	Education, costs, transaction per hour per employee, customer satisfaction, revenue.
Candidate F	Operational Director	Safety, delivery precision, delivery performance, lead time, cost control, availability, efficiency, investments, quality, productivity capacity utilization, cost pricing (material costs, packing of materials, labor costs, overhead costs), sustainability, culture.
Candidate G	Inventory Manager	Availability, days in stock, safety stock, sales customer service, quality, inventory, lead time/delivery time, location, efficiency, delivery time and performance, transportation frequency, costs, processes in warehouses, social and environmental sustainability.
Candidate H	Management Director	Customer service, flexibility, health, demand, safety, availability, improve products, delivery precision, location, lead time, quality, stock-levels, machine efficiency, sales.
Candidate I	Regional Operations Manager	Health and safety, delivery performance, availability, stock levels, improve products, location, capacity, customer service, productivity, volume/growth, costs, sustainability.

Candidate J	Managing Director	Safety, delivery precision, productivity, quality, efficiency, delivery performance, lead time, information systems, stock utilization.
Candidate K	Regional Operations Manager	Costs, labor costs, product quality, customer service, lead time, investment, delivery performance & precision, environmental sustainability.
Candidate L	Sales Region Manager	Sustainability, profitability, automatization, digitalization, costs, revenue, growth, safety, location, delivery time/ lead time, investment plans, culture, capacity, efficiency, sales, employee development, customer service.
Candidate M	Industrial Manager	Profitability, customer service, delivery precision, EBIT, lead time, health and safety, days in stock, availability, scrap optimization, quality, investments, price and optimization of packaging, sustainability, utilization.
Candidate N	Regional Director	Profitability, EBIT, growth, sustainability, automatization & digitalization, investments, health and safety, new products location, flexibility, adaptability, transportation, governmental issues.
Candidate O	Logistics & Sales Manager	Fill-rate, availability, order lines picked, volume, flexibility, location/local, stock, freight costs, net costs, revenue, customer requirements, demand, alternative costs, utilization, inventory management.
Candidate P	Managing Director	Profitability, costs, social and environmental sustainability, safety, investments, flexibility, adaptability, political situation, regulations, energy, product design, competitors, customer behavior.

4.3.1 Interview Findings

The parameters from the empirical data are summarized and compiled into one figure to contribute with a holistic view of parameters. To facilitate the comparison between literature and empirical data, the parameters have been summarized and divided into strategic, operational, costs, and external parameters, like the conceptual framework. Figure 11 presents the interview findings regarding parameters in the supply chain network of Lindab. The interview findings will be further analyzed in chapter 5.

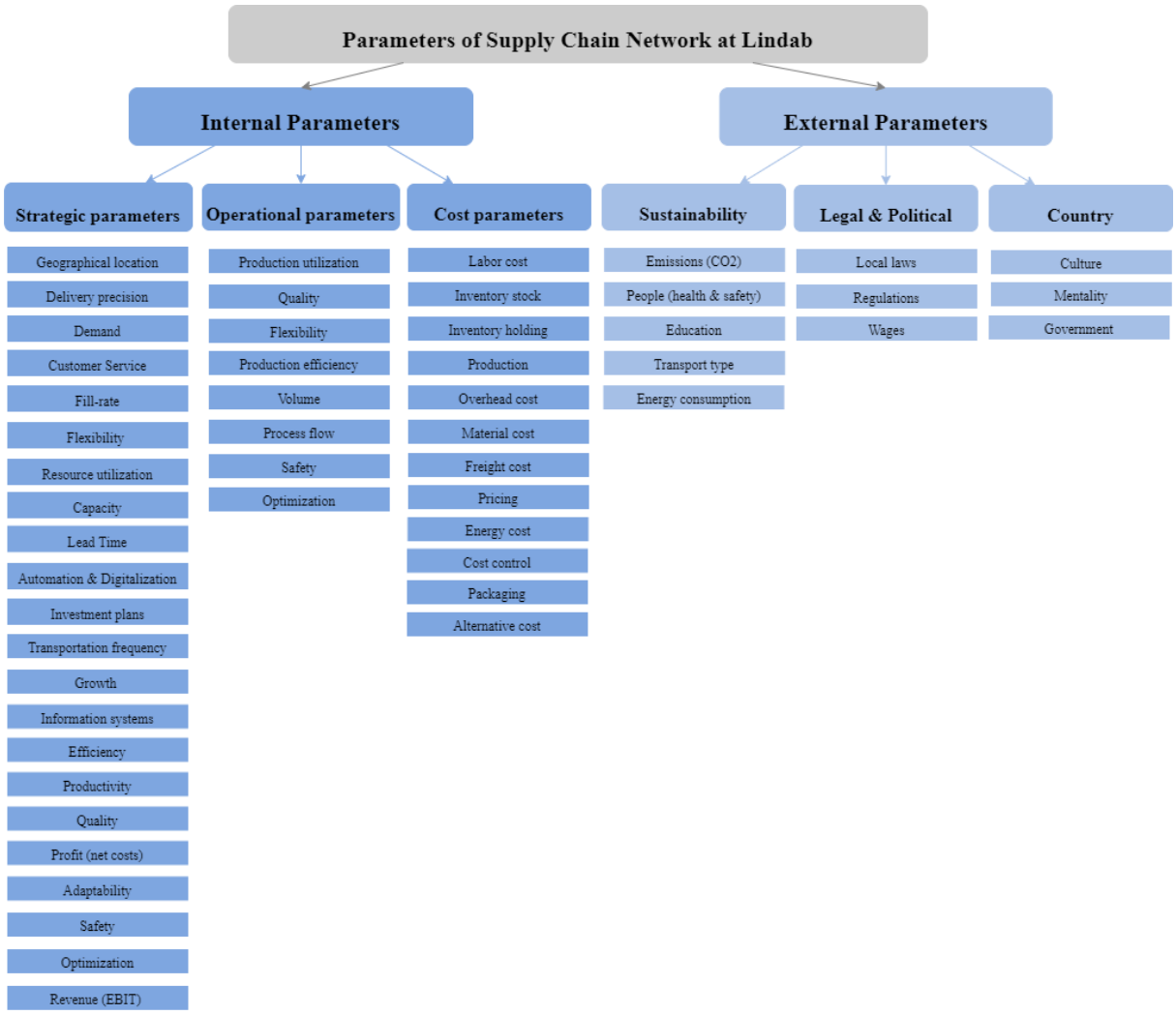


Figure 11. Parameters from the empirical data compiled into internal and external parameters

5. Analysis

In the following chapter, the findings from the interviews are analyzed. This is done in connection with literature to compare theory and empirical data. Firstly, change projects discussed during the interviews are analyzed to understand relevant redesign options. Thereafter, the important parameters are analyzed through a thematic analysis. This is done by categorizing parameters to facilitate the understanding of different types of parameters. Lastly, the result of the most important parameters, empirical data, and theory are combined.

5.1 Redesign Options

The interviews, hence the empirical data, show that the focus of approaching change projects at Lindab in the past has been on costs. When redesigning the logistics setup or initiating other change projects, the evaluation of costs has been the main parameter. This is a clear pattern from historical change projects, but it is also confirmed to be of great importance today. However, except costs, there are several other influencing factors that drive changes in Lindab's supply chain network today.

One change project or redesign option frequently discussed by the candidates is decentralization. Having central production has been beneficial historically, but the increased focus of customer service has resulted in new requirements. As highlighted by Cohen and Roussel (2013), financial parameters are one of the main drivers in change projects. Candidate A mention that, historically, they have done simple calculations of transportation costs and comparing direct costs at the central unit vs. local unit. However, the reviewed literature state that market requirements and customer service are significant driving factors for changing the supply chain (Dev, Shankar & Dey 2014; Lemoine & Skjoett-Larsen 2004; Rushton, Croucher & Baker 2022), which is confirmed by several candidates as well. The empirical data shows that short lead times are of importance to achieve high customer service which also is supported in literature. Lemoine and Skjoett-Larsen (2004) discuss that 24-48h lead time is a common requirement in Europe which consequently drive companies to reconfigure their supply chains. The candidates also mentioned environmental sustainability as an influencing factor for decentralization. For example, candidate B mention that it is more beneficial to produce large products locally due to minimized transported air/ utilization of transport capacity. In relation to transportation, both financial and environmental factors are affected by decentralization. Financially, the local production will reduce transportation and freight costs which consequently affect the impact on the environment. Furthermore, several candidates touch upon the topic of "where to produce what". Since all production will not be moved from central units to local units, it is important to decide on which product families that will be produced locally. In summary, decentralization is considered an ongoing project that will affect the supply chain design at Lindab. Therefore, it is important to evaluate different parameters to make the right decisions in relation to the logistics set-up redesign.

A redesign option connected to decentralization, is the planned expansion of the facility in France, discussed by Candidate M. The production for products sold in France is currently done in Prague. But since the capacity in Prague is over-utilized, and there is no more space to expand, the decision has been made to expand the facility in France and move production from Prague to the new facility in France. The driving factors, except capacity, are freight costs, lead times, and environmental factors like cubic meter transported. The driving factors for the redesign of the production- and distribution network is in consistence with theory. The challenge with re-locating the production is, as mentioned before, to decide which product families that should be produced locally.

Another influencing factor for change is digitalization. Candidate N discuss digitalization as a main change project in the future where the company need to adapt to a new era of digitalization. This factor is also mentioned by Rushton, Croucher and Baker (2022) as an influencing factor that drives change. The digitalization will imply new IT systems, more automation, and robots throughout the organization. In addition, this will require new skills among the employees. Digitalization will affect the whole organization which will include change management. Change could be difficult among employees since people have a strong connection to culture and routines. Therefore, the willingness to change will become a challenge for companies when going into the digital era.

Furthermore, acquiring companies is an ongoing project that is defined as a change project among the candidates. The reason for acquiring new companies is to be competitive on the market, retain the market share, obtain knowledge, and have a geographical presence. These driving factors are also supported in literature. However, by acquiring companies, the culture of Lindab needs to be applied into the new company. Therefore, education is important, but this will contribute as a change for the company and consequently affect the willingness to change.

Additionally, it was learned through the interviews by multiple candidates, that the continuous process of reevaluating historical decisions was a common driver for doing change projects. Hence, looking into whether a decision that met needs with great satisfaction years back, do these decisions still satisfy the needs for the current day or can it be changed to become of more efficient manner. A common example of this mentioned by several candidates, was the evolvement of labor costs in the Czech Republic. The labor costs and rate in general was historically low in Czech Republic compared to other European countries. This fact has resulted in many production operations being located in the Czech Republic, hence to lower labor cost. However, today, the labor costs in the Czech Republic have increased significantly and, also the unemployment rate is extremely low. Thereby it has become more expensive to run production in Czech Republic, and more difficult to find employees. Hence, the historical decision does no longer fit the current setup with equal efficiency and benefits, and thereby is a decision with interest of reevaluating.

5.2 Analysis of Parameters

In the following, the parameters of which have been mentioned in the interviews will be analyzed in order to establish patterns and which parameters have shown to be of high importance, the drivers, and the reasoning for incorporating them in the final framework. All of which is done in order to extract sufficient and exact data from the interviews, towards the developing of the final framework.

In order to conclude on which parameters have been mentioned with the highest frequency, and thereby can be used as argumentation for parameter of importance, a summarizing table of parameters vs. candidates have been conducted (see table 6). For the matter of making the parameters more understandable and reduced to an amount of which can be worked with, they have been divided into definitions of which can consists of different aspects. As an example, the parameters of cost, consists of multiple cost factors like, labor, transportation, inventory etc. Additionally, parameters of which are referred to differently have been combined, in example delivery time and lead-time are a combined parameter. For defining a parameter to be of importance the target level in percentage was $\geq$30%, hence 30% or more of the candidates have mentioned the parameter to be important, these parameters are highlighted in color in table 6 below. The level of 30% was chosen in collaboration with Lindab, driven by a discussion on important parameters with different employee positions.

Table 6. Total appearance of different parameters relative to all candidates from the interviews

Parameter	Candidate																%
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
Automatization & Digitalization	✓											✓	✓	✓			25,00
Availability						✓	✓	✓	✓				✓		✓		37,50
Culture (mentality, people, behavior)						✓						✓				✓	12,50
Capacity (volume)	✓	✓	✓			✓				✓		✓			✓		43,75
Costs (labor, control, pricing, country specific, material/cm^3 price, freight/transport, packing, inventory, production, overhead, EBIT, net costs, alternative costs)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	93,75
Customer service (customer satisfaction)	✓				✓		✓	✓	✓		✓	✓	✓		✓	✓	62,50
Delivery performance (delivery precision, reliability)		✓	✓			✓	✓	✓	✓	✓	✓		✓				56,25
Demand		✓		✓				✓							✓		25,00
Education (employee development)					✓							✓				✓	18,75
Efficiency (logistics systems, production, machinery, transport)	✓	✓				✓	✓	✓		✓		✓					43,75
Flexibility (adaptability)		✓		✓				✓					✓	✓	✓	✓	43,75
Growth	✓								✓			✓		✓			18,75
Health & safety (incidents per month)	✓					✓		✓	✓	✓		✓	✓			✓	50,00
Information systems				✓						✓							12,50
Investments (plans, technology, resources, companies, market share)	✓					✓					✓	✓	✓	✓		✓	43,75
Lead-time (delivery time)		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓				62,50
Location (geographical, local/central)	✓	✓					✓	✓	✓			✓		✓	✓		50,00
Optimization (packaging, price, processes, scrap)													✓				6,25
Productivity (transactions/ employee, transactions/hour, order lines picked)				✓	✓	✓			✓	✓					✓		37,50
Products (design, dimensions, complexity, quality, innovation)		✓						✓	✓		✓			✓		✓	37,50
Profitability (profit, revenue, sales)				✓	✓		✓	✓				✓	✓	✓	✓	✓	56,25
Quality (materials, processes)		✓				✓	✓			✓			✓				31,25

Regulations (governmental issues, laws, wages)			✓										✓			✓	18,75
Stock (Inventory, handling, safety stock, days in stock, quantity, levels)		✓		✓			✓	✓	✓				✓		✓		43,75
Sustainability (environmental & social)	✓	✓	✓	✓		✓	✓		✓		✓	✓	✓			✓	68,75
Transportation (type/mode, frequency, fuel, fleet)				✓			✓							✓			18,75
Utilization (volume, machinery, capacity, resources, inventory, stock, fill rate/ratio)	✓	✓	✓	✓		✓				✓			✓		✓		50,00

From that target of ≥30%, we can conclude from table 6, that the parameters of importance are availability, capacity, costs, customer service, delivery performance, efficiency, flexibility health & safety, investments, lead time, location, productivity, products, profitability, quality, stock, sustainability, and lastly utilization.

With the conclusion of the abovementioned important parameters from the interviews with the candidates, the parameters can be analyzed further for defining patterns among both internal and external parameters relative to both purely the interviews, but also relative to the parameters of which were defined in the conceptual framework based on the literature (chapter 3.4, figure 7). All of which will be analyzed in the following chapters within the different areas of cost, strategic, operational, and lastly external parameters.

5.2.1 Cost Parameters

Comparing literature and the empirical data there are several similarities regarding costs. In figure 12, cost parameters from literature vs. empirical data are presented. The dashed line illustrates the common parameters mentioned in both literature and the empirical data.

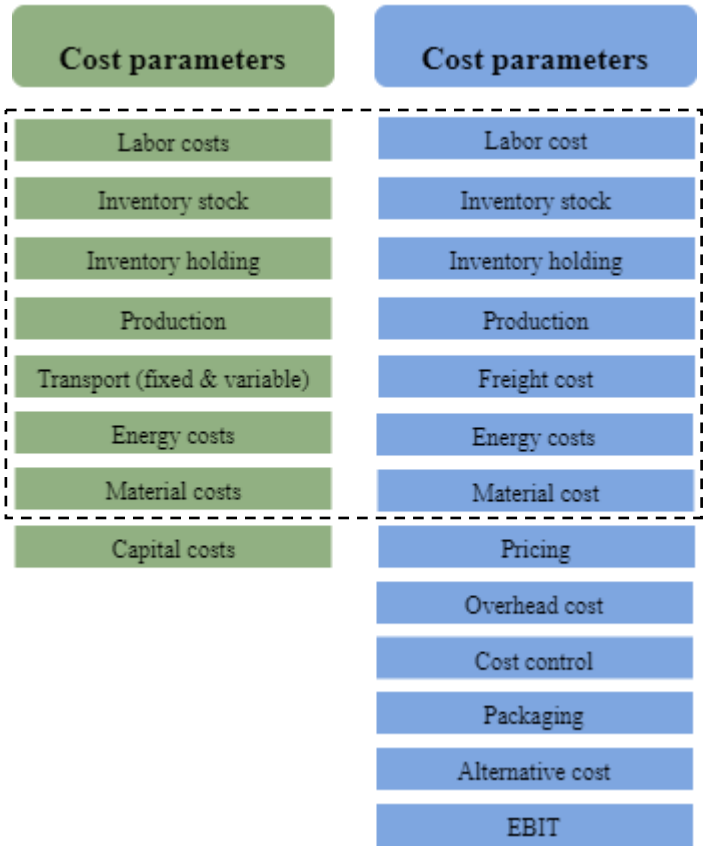


Figure 12. Cost parameters in literature vs. empirical data (Left (Green): Literature, Right (Blue): Empirical data)

To motivate a business case, it needs to be profitable. When discussing change projects and important parameters, all candidates agree on costs and profitability as important where EBIT is mentioned as a specific measurement. The essence and reasoning behind the cost parameters is the idea of saving money, which goes hand in hand with profitability. As companies are driven by revenue, it is obvious that all employees consider cost parameters in relation to their responsibilities. There are different types of costs whereas overhead costs, labor costs, freight costs, and packaging costs are mentioned by different candidates. As some candidates explain, material costs should be equal independent on location, and that is most likely the reason for not being mentioned as frequently during the interviews. Low labor costs in Czech Republic were commonly mentioned during the interviews as the driver for putting production in Prague. But as Candidate A and Candidate P mention, the difference in labor costs in Czech Republic and a high-cost country is not as significant today. Therefore, the parameter of labor costs in different countries will not outweigh other cost parameters today as it did before. In relation to theory, costs in general are commonly mentioned, but Lanza et al. (2019) especially mention labor costs as the greatest share of costs for manufacturing companies. Other costs mentioned by Lanza et al. (2019) and Rushton, Croucher and Baker (2022) are capital costs, material costs, transportation costs, and energy costs.

5.2.2 Strategic and Operational Parameters

In terms of strategic and operational parameters, some parameters are represented in both categories. The comparison between parameters in literature and the empirical data is presented in figure 13. The dashed line illustrates the common parameters mentioned in both literature and the empirical data. Furthermore, patterns in data have been identified and categorized, and the most important parameters mentioned in the empirical data are analyzed in this chapter.

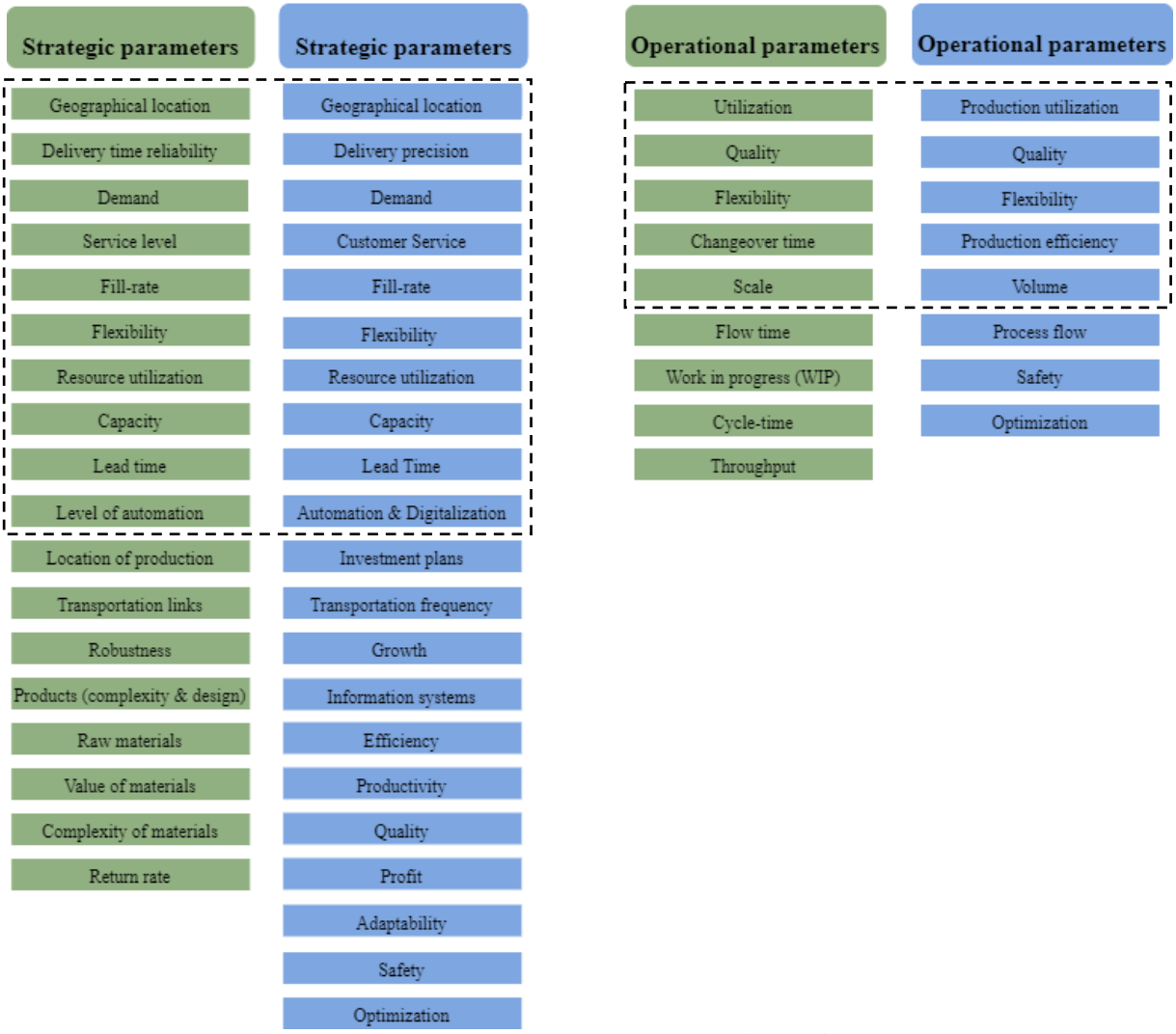


Figure 13. Strategic and Operational parameters in literature vs. empirical data (Left (Green): Literature, Right (Blue): Empirical data)

Customer Service

The case study showed that a frequently mentioned parameter in the empirical data is customer service. Several candidates agree on customer service being the parameter prioritized the highest in combination with costs. Meeting customer requirements are important to stay competitive on the market. According to Candidate L, all factors should be driven by achieving better customer service. Customer service in general is driven by several sub-parameters. As mentioned by several candidates, customer service can be quantified by the parameters: delivery precision, lead-time, quality, and availability. By having the right components available, good quality of products, deliver on agreed time, and have short lead times are considered success factors for a high customer service. However, all candidates do not share the same perspective of customer service. Some candidates, like sales managers, are in the position of frequent contact with customers and therefore value customer service as the most

important parameter. While candidates as inventory managers work with other prioritized parameters but are indirectly affecting the customer service. For example, days in stock and availability are parameters connected to inventory. But having efficient inventory levels will automatically affect customer service since it will influence lead time and delivery reliability. In consistence with theory, Melo et al. (2009) discuss service level as an important parameter while Miltenburg (2005) and Lanza et al. (2019) in particular highlight the strategic importance of delivery performance, lead time, and quality.

Health and Safety

Many of the interviewees also agreed on health and safety being an important parameter where Lost Time Incident Frequency (LTIF) is mentioned as a common measurement. As Lindab handle heavy material in their production, it is important that the employees feel safe at work. The parameter of health and safety is commonly mentioned by managing candidates who are responsible for the safety at the work floor. Candidate F among others state that safety should be the number one priority. Candidate L highlight the importance of caring for each and every employee at Lindab both mentally and culturally. As Candidate F also mention, health and safety are connected to culture and people behavior which needs to be taken into consideration when taking decisions in different geographical locations. Parameters regarding cultural differences are also supported by Lanza et al. (2019). Besides that, literature do not highlight the parameter of health and safety as the empirical data. Since Lindab is a manufacturing company, working with different machines and handling heavy material, the parameter of safety is of high importance and therefore mentioned frequently during the interviews.

When taking decisions regarding changes in the supply chain network, health and safety should be given and as prioritized despite the location. But Candidate P mention that safety is not as prioritized in every country because of different mentalities and cultures. It is also highlighted that the human factor is a risk since all humans can make mistakes that could affect the safety. Even though health and safety are rather intangible parameters and therefore difficult to quantify, it should be included in a decision-making tool. To quantify safety today, Candidate F explain that they measure number of incidents per month to avoid future unsafe situations.

Flexibility

Several candidates mention flexibility as a parameter of importance. The essence of flexibility in the data is although divided as a strategic parameter and an operational parameter. Some candidates describe flexibility as the possibility to move around capacity without compromising quality. But flexibility is also described as the prerequisite to not only set up a system but always being able to adapt to changes. Customers and customer requirements can change which makes it important to be flexible in order to adapt to those changes and keep the market share. For example, flexibility involve the possibility to supply material from more than one pre-set supplier. The meaning of flexibility is most likely distinguished differently among the candidates due to the different positions and responsibilities they are possessing. Flexibility is also supported as an important parameter by several authors like Meixell and Gargeya (2005), Miltenburg (2005), Melo et al. (2009), and Ferdows (2018) who also mention the importance of flexibility in production processes. However, it would be challenging to include flexibility in a decision-making tool since it is difficult to quantify. Furthermore, flexibility is driven by several organizational factors that should be in place despite a decision-making tool, for example working procedures, contracts, and regulations.

Investments
Several candidates at the different interviews also mentioned the parameter of investments. Investments are many things when talking to different people but have been mentioned in the aspects of both education, automation, digitalization, and growth.

Firstly, talking investment in relation to education, it was emphasized in the essence of investing in employees and the capabilities they bring to the company. It was highlighted that it is a necessarily to invest in educations to keep evolving and developing the employees, hence never become static in the position and their capabilities. In connection to that, it was also mentioned that it can be necessary to invest in new resources, when education is not sufficient in order to solve a current situation. Secondly, investment was mentioned in the aspect of both automation and digitalization. In this aspect the parameters are emphasizing how it is necessary to invest in technology that will keep the company competitive in the world-wide digitalization, along with investing in automated technology to have an efficient production and product flow. This is also in line with current theory on the topic, mentioned by several references like, Prasad and Sounderpandian (2003) and Wanke and Zinn (2004). Especially investments in robots and co-bots were mentioned by several candidates, but with that in mind, it should never be to directly replace a human employee. Lastly, investment was a parameter with the aspect of growth, as candidates says it is inevitable to invest in different aspects in order to keep growing as a company. This is discussed both in terms of being competitive relative to other companies, and in order to keep optimizing and streamline the existing flows at the company, but also in order to keep meeting the rising customer demand.
In summary, it can be concluded that the parameter of investments, can be different relative to who you ask, and which position they are responsible for. However, it can be argued that the purpose of the parameter of investment is to optimize something to the better, whether it is education, digitalization, automation or growth, the essence of the end-goal for the parameter is the same.

When including the parameter of investment in the framework, it needs to be highlighted that it is a parameter of different definitions relative to different departments. Though it can be argued that the parameter will have a natural definition relative to the project of which it is included in, as example doing a change project in the production is, in conclusion from the interviews, more likely to be an investment in technology (automation and digitalization) rather than for example education and growth.

Products
Through the interviews different parameters in the essence of products were also mentioned. Both including, product innovation, product material and product complexity. It was all driven by the challenges that Lindab faces when producing and distributing the products. It was learned from the interviews that these challenges revolve around the fact that Lindab produces ducts with different product dimensions. These dimensions affect how fast a given product can be produced, which equipment is needed and how different products are transported. As an example, the higher the dimensions of a product, the more complex the transportation can be, especially in utilizing the space. Thereby products are considered to be an important parameter when changing things, as they, as mentioned above can affect different parameters, and thereby be a reasoning behind a decision. The parameter of product is also supported by the literature in the reference of both Prasad and Sounderpandian (2003) and Wanke and Zinn (2004), talking about the complexity of the products and how that affects production parameters in general.

Geographical Location
An additional parameter, which showed to be of importance from the interviews with Lindab candidates was the parameter of location. Where different sites are located both relative to different countries, but also relative to being local or not. The importance, which was empathized through the interviews for this parameter, was both in terms of being able to deliver sufficient customer service in relation to location. Meaning, can lead-time for different demands be decreased. However, it was also in the aspect that location affects both freight costs, and the environmental footprint of different transportation links. The aspects of how location is a parameter of importance is also emphasized through different references of the theoretical framework from both Miltenburg (2005), Rushton, Croucher and Baker (2022), and Wanke and Zinn (2004), all in the essence of the logistic and sustainability point of view and the challenges that comes with that function.

When using the parameter of location in the framework, it was with the reasoning of having a great impact on where different functions are located relative to the costs, emissions and customer service the different location brings with them. Meaning the parameter is in fact of importance for the framework, as it will affect other parameters along with setting the grounding for how different processes need to interlink.

Efficiency and Productivity
Other parameters which were mentioned several times by different candidates was the parameter of both efficiency and productivity. Firstly, it was mentioned to cover the processes of having efficient and productive logistics systems, though not indicating a specific target on specific processes with the logistics connections, but rather an overall efficient and productive system. Though two specific targets of which could be empathized to be a parameter of productivity is a measure of transportation frequency, and the measuring of transaction per employee which then contribute to the overall productivity parameter. Moreover, the two parameters were also mentioned relative to the production of Lindab products. In this connection, productivity and efficiency were in relation to the production machinery, hence how well the production was performing in, for example, relative to quality, which can be argued to contribute to the parameter of efficiency.

Lastly, efficiency and productivity were emphasized by several candidates as a parameter of importance, which are relative to the different processes and flows at the different warehouse. Hence, the parameters shall indicate how productive and efficient specific processes and flows are performing in order to evaluate on where to execute changes. In relation to implementing the two parameters in the final framework, it can be concluded that the parameters must be thoroughly defined in order to understand the connection in which the parameter is used. Productivity and efficiency can be many things, but as mentioned above and in the interviews, these parameters are typically enabled by drivers like efficiency of machinery, productivity of transaction by employees, and transportation frequency among others. These enablers are important to have defined in the framework in order to have a common understanding of what is meant by being efficient and productive.

When looking at both efficiency and productivity as a parameter relative to the literature and the conceptual framework presented in chapter 3.4. It is clear that these in fact have not been mentioned as parameters in the literature, though it can be argued that both efficiency and productivity can be difficult to quantify and the matter of including them in decision making are rather considerations than parameters of which are driving a decision. Hence, quantifiable

measures are in terms of literature and current state of the art, more likely considered important than relative to non-quantifiable parameters.

Measuring parameters

Conducting the interviews, several candidates highlighted different measuring parameters of importance when doing change projects, but also in the understanding of everyday performance, specifically parameters as fill-rate, volume, capacity and utilization. All of which the aforementioned parameters were highlighted to contribute with measurements of which can be used to understand and drive different change projects. Specifically, the parameter of fill-rate was mentioned by more than half of the different interviews candidates, and in the definition of how filled different trucks are, also mentioned as how much of the available volume of the trucks are used. It was empathized through several candidate that the fill-rate was in high importance in order to have as much in the trucks as possible. Hence for both efficiency and environmental aspects, meaning delivering as many products or materials as possible with each truck, to have an efficient flow of materials, but also to reduce the carbon footprint of the distributions.

Another measuring parameter was the parameter of capacity. Capacity was empathized to be a parameter of importance to evaluate on for example different warehouse capacities, in order to move around capacity like mentioned in the parameter of flexibility. Additionally, the capacity parameters were also mentioned to be used in order to decide where to locate different production flows. Hence, argued as a parameter of high importance relative to the change project of where to produce. In connection to capacity, the parameter of utilization was mentioned, meaning how much of the capacity is actually used, hence over- or underutilized relative to a given target. The utilization was argued to be a parameter of great importance in order to understand how different processes are in need of scaling up or down, hence one thing is knowing how much capacity one has, another thing is knowing how the capacity is used, or rather that can be more efficient.

The measuring parameters were argued, from the interviewees, to be of importance for making decisions in future change projects, and also showed to be parameters of which had historical importance in previous change projects. Thereby it can be empathized that the measuring parameters are important to include in the framework as it gives understanding on different processes and enable the data to be used for making decisions.

Having different measuring parameters of importance are also highlighted in general from many different sources like Ferdows (2018) and Melo et al. (2009). It is highlighted as the base for making data driven decisions, and to have accurate measuring parameters to use for the different decisions, thereby the theory does in fact confirm the importance of the different measuring parameters Lindab uses.

5.2.3 External Parameters

External parameters are defined as sustainability, political, legal, and country, but as sustainability is frequently referred to as an important, it is analyzed separately. Figure 14 presents the comparison of parameters connected to sustainability, while figure 15 presents political, legal, and country specific parameters. The dashed line illustrates the common parameters mentioned in both literature and the empirical data.

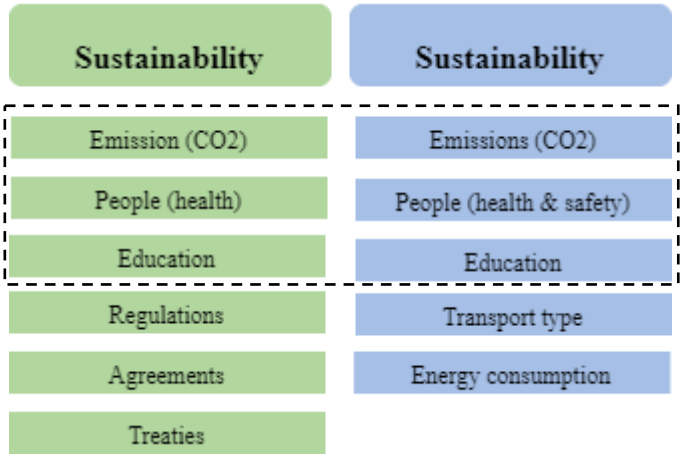


Figure 14. Sustainability parameters in literature vs. empirical data (Left (Green): Literature, Right (Blue): Empirical data)

Sustainability

It is widely known that sustainability is an important topic today. Sustainability has gained more attention and has become more prioritized by companies and stakeholders where Lindab is no exception. Rushton, Croucher and Baker (2022) highlight sustainability, and especially environmental sustainability as a driver for change in companies. Several candidates agree on this aspect and discuss primarily the environmental sustainability. Candidate K mention that sustainability can be measured by CO_2 emissions and km of transport. Green initiatives could also be connected to financial parameters. As discussed by Candidate I, reducing material or packaging material in a sustainable aspect will consequently have a positive impact on costs since you do not need to buy as much material. Another aspect in connection with environmental sustainability is scrap optimization, highlighted by Candidate M. Waste handling and scrap steel should be handled in an efficient way to save energy and reduce emissions. Furthermore, one major change project, mention by Candidate F and Candidate N, is that Lindab is aiming to use fossil free steel in their products. This is a long-term goal and will require new investments. However, sustainability is an ongoing project for companies all over the world, and as it is an immature parameter, there is still a lot to come. To cope with this parameter, several candidates explain that the company have hired a team of sustainability experts that will help the company to act in a sustainable matter. Considering social sustainability, parameters as education and employee development are mentioned by some candidates. Supported by Govindan, Fattahi and Keyvanshokooh (2017), social sustainability is an important aspect to make people feel happy at the workplace and stay at the company for a long time. The challenge with sustainability is the lack of data. Since it is a relatively new parameter, companies struggle with collecting and presenting data to quantify the parameter. The consequence of not having data will mean that the parameter cannot be evaluated and included when taking decisions, and by that, decisions will be made upon feelings and assumptions.

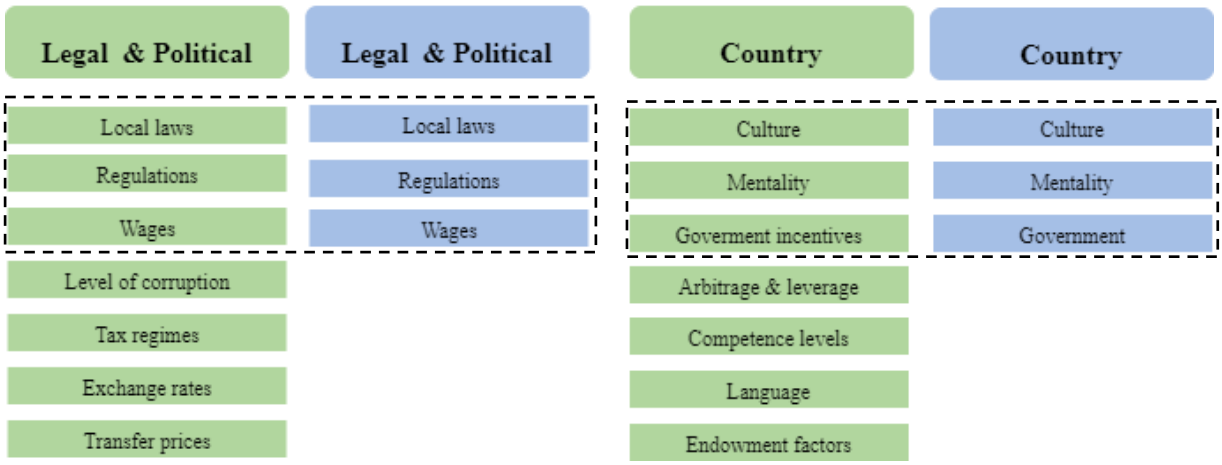


Figure 15. Legal, political, and country specific parameters in literature vs. empirical data (Left (Green): Literature, Right (Blue): Empirical data)

Other external parameters

Categorizing the parameters into external parameters resulted in a few external parameters regarding legal, political, and country mentioned by the candidates. This is a gap in comparison with literature where several external parameters are mentioned, as shown in figure 15. However, Candidate N discuss how governments have different levels of influence depending on the country and how changes and decision-making therefore needs to be adapted to each country. Hence, when making changes, the decision-maker needs to consider the parameter in relation to the country where the change is made and not as a company broad parameter. Furthermore, legislation and different regulations in countries and regions are important to consider when evaluating different decisions. One specific legislation mentioned by Candidate C is the regulations of commercial road transport controlled by the European Union. The legislation involves regulations of how truck drivers may operate which in turn affect the route planning and management of efficient transports at Lindab. Candidate P also highlight the importance of ethical business and how the political situation in a country needs to be evaluated before expanding the business. This is an important parameter to consider but has not been mentioned frequently during the interviews. The interview with Candidate P was conducted in a point of time where the circumstances in the world regarding the Russian invasion of Ukraine was crucial. Therefore, the significance of this parameter became more highlighted during this interview compared to others.

In general, the reason for these external parameters not being mentioned frequently in the empirical data is most likely due to lack of importance compared to other parameters. There are several parameters, like costs and customer service, that are of higher importance for the company and therefore gains more attention from the employees.

5.3 Resulting Parameters

As a result of the analysis, the most important parameters from literature and the empirical data are presented in table 7. The parameters have been grouped accordingly to the identified themes of which were found in the analysis. As an example, the parameter category of *Cost,* with the corresponding sub-parameters of *Labor, Freight, Material* etc. Furthermore, this facilitates the use of the framework and the understanding of what different parameters contribute to. The identified parameters in table 7 will be the starting point of building the framework in chapter 6.

Table 7. The final parameters of empirical and literature findings

The Final Parameters of Empirical and Literature Findings						
Cost	**Investment**	**Savings**	**Product specification**	**Customer service**	**Measuring**	**Efficiency**
Labor Freight Material Overhead Inventory Production Packing Alternative	Education Automation Digitalization Capabilities/ Resources Technology Companies	Profit Revenue (EBIT) Sales	Dimensions Material	Delivery - precision Lead- time Quality of products Inventory levels / availability	Fill-rate Volume Capacity Utilization	Efficiency of machinery Warehouse processes
Productivity	**Sustainability**	**Location**	**Health & Safety**	**Country**	**Legal & Political**	**Flexibility & Adaptability**
Transactions per employee Transportation frequency	Emissions (CO_2) Energy consumption Transport (distance) Social/employee satisfaction	Costs Emissions Customer Service	Incidents per month Employee satisfaction	Culture Mentality Competence levels Government	Wages Regulations Laws	Move capacity Resources

6. Developing the Framework

In this chapter, the process for developing the final framework is structured. This includes the framework logic and approach along with the first version of the framework. Furthermore, two real-life cases at Lindab are used to test the framework, find improvement areas and to analyze the usage of the framework. The chapter is finalized with a summary of modifications needed to complete the final framework.

6.1 Framework Logic and Approach

Continuously from analyzing both the interviews and the literature, the important parameters have been defined, and the reasoning behind the framework is established, hence the development of the framework can start. At first, a general and holistic framework was built in order to visualize the gains and insights from the aforementioned sources, to get a holistic view of the parameters of choice and to understand the essence of the final framework from the matter of the thesis research topic. This general framework is working as a general approach to using the logic, though it is not case specific, hence the general approach is a starting point for using the framework. The physical developing of the framework was conducted in Microsoft's Excel program. Due to the fact that Excel is a common tool in many businesses for evaluating and working with data, it was in collaboration with Lindab, chosen to be a suitable tool for developing, mediating and using the framework. The first version of the framework is presented in figure 16.

The framework is intended to work in two phases of execution, at first a phase of quantifiable measures and a second phase of non-quantifiable parameters as seen in figure 16. The logic of having both a phase of quantifiable and non-quantifiable parameters is due to the nature of different parameters being difficult to quantity. As an example, social sustainability is considered individual unique (relative to the persons asked), hence difficult to quantify. While utilization as an example is quantifiable as it is a parameter of which is based on defined mathematical measures. Hence, as also learned from the interviews as earlier established, not all parameters which are used for decision making are in nature data driven. Additionally, the first phase of quantifiable parameters is divided into two steps. Step 1 consists of calculations on the cost parameters, as they are most comprehensive, and then step 2 concerns calculations on the other quantifiable parameters, which is visualized in figure 16.

In connection to this, as the framework is with the purpose of acting as a decision tool which is data driven, the purpose of firstly conducting a first phase of quantifiable data is to accommodate the nature of being data driven. Secondly the non-quantifiable parameters cannot be ignored as some have shown to be of importance (like sustainability), and thereby must be used as considerations on top of the measures of the quantifiable parameters. Hence, firstly quantifiable parameters are evaluated in phase 1 and secondly the non-quantifiable measures are considered relative to the quantifiable ones, phase 2, step 3. The differentiation between quantifiable and non-quantifiable measures, were chosen in relation to theoretical definitions of which were described in the literature review by Watson et al. (2013) of being either measurable (quantifiable) or conceptual (non-quantifiable).

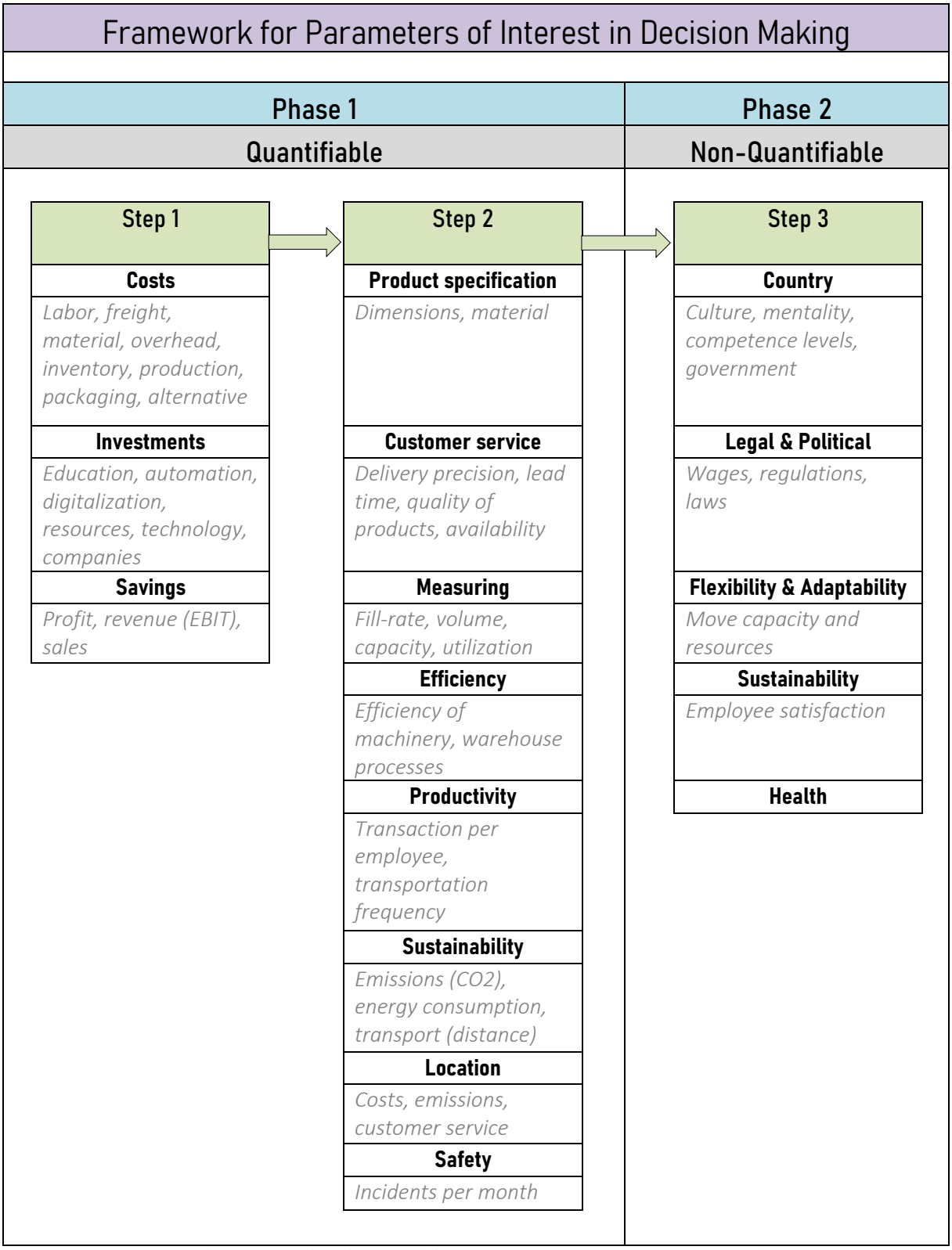


Figure 16. The first version of the framework for evaluating parameters in supply chain change projects

6.2 The Process of Testing the Framework

As the purpose of the framework is to be general and used on different types of change projects, it is necessary to evaluate and validate the framework. This is done by testing the framework on different cases, also called change projects. In the scope of time, two cases will be used to test the framework. Testing will be used to refine, sharpen, and enrich the framework. The data obtained with the test will present a potential source of validity information that will be used to develop the framework by changing, adding, or extracting information from the framework. In addition, by testing the framework on real cases, it will provide Lindab with knowledge and insight on what parameters they have data on and what parameters they do not have data on. This is an important aspect to understand in order to become data driven and make data driven decisions.

It was noticed that a first step of developing the framework was to establish a common logic and understating of the framework and the parameters included. This was needed to be agreed on in order to use the framework in a successful manner among different Lindab employees. For this matter, a workshop including positions from both logistics and production from Lindab and the students ourselves, was conducted in order to have a discussion and brainstorming on the current framework. Hence, how it was working, the logic and future adjustments, with outtake in figure 16. In this connection, the main challenge was establishing common definitions of the different parameters, to enable common use and establish the data needed for each parameter. Hence, a common plan for how the framework would act in a data driven manner to support decisions and relying on which data. The adjustments and changes made in relation to the first version of the framework are summarized in table 8. The final definitions of the parameters are presented in Appendix 2. The definitions were established to capture a general setting to cover several understandings of the parameters. Moreover, the definitions were expected to need modifications as a result of testing. Hence, Appendix 2 represents the final resulting parameters used in the final framework.

Table 8. First changes in the framework based on the workshop

Parameter	Change	Reasoning
Efficiency	"Warehouse processes" in Efficiency is removed.	It was emphasized that the parameter would be covered with the OEE (overall equipment efficiency).
Health & Safety	Combined "health" and "safety" as one category with additional parameters (LTIF and ergonomics).	Health and safety are often mentioned together. Additionally, having safety as one quantifiable measure does not tell much. The parameters considered relative to each other provides more information then individually.
Location	Moved the parameter "Location" to phase 2 (non-quantifiable).	The parameter is considered as a comparative parameter where you evaluate differences rather than numbers.
Product specifications	**"**Material" was removed from Product specifications.	The parameter is covered by the parameter "material costs" and therefor considered redundant.
Resilience	"Flexibility" and "adaptability" were grouped into one category named resilience.	It was emphasized that the definition could be made more general. Additionally, the parameters considered relative to each other provides more information than individually.
Sustainability	Distinguished between environmental and social sustainability.	The name of each category was changed to clarify the different parts of sustainability (social and environmental).

For the matter of being consistent in testing the framework to further develop it, a method consisting of different steps were conducted as seen in figure 17. Firstly step 1 *"Introduction"*, here a given case/project which is up for change is introduced with the reasoning behind it, challenges, current solution, and alternative solutions. Next, step 2 of "*Establishing the parameters"*, here the framework of which is provided is used to go through parameters of interest. As a case/project in nature can be unique, so will the useful corresponding parameters be, though it is highly empathized that one considers all parameters of which the framework consists of. Hence, to enable a brought aspect to change and enable a data driven point of argument. Moreover, step 3 of "*Gather data on parameters"*, here the data of the chosen parameters are gathered in the method(s) of which is possible, in example from Enterprise Resource Planning (ERP) systems, Warehouse Management System (WMS) etc. are plugged into an example data sheet to enable further common analysis on all data sources. When step 3 is conducted, step 4 of "*Is all needed data available?"* ask the question of whether all parameters chosen to get data on, does in fact have availability of data. For answering, a decision of *"YES"* and "*NO"* is chosen relative to fit a current parameter. If the answer is *"Yes"* one move to step 5 of *"analysis",* if the answer is "*NO"*, one further moves to the step of "*How should the parameter be used?"*, here one decided relative to a current parameter rather it is used in the form of data-driven or consideration, hence quantifiable or non-quantifiable. If a parameter is chosen to be Data-driven, one loops back to step 3 of "*Gather data on parameters".* If a parameter is chosen to be of the nature *consideration*, one moves to the 5th step of *"Analysis"*, hence all parameters must be evaluated individually in this *YES/NO* decision. In the analysis, the input parameters are analyzed relative to the described case using a comparative nature if multiple case/project scenarios are included, or an evaluation nature if one case/project scenario is included. Lastly step 6 of *"assessment"* is conducted, here an assessment relative to the findings of the analysis is emphasized, hence what are the results and the future considerations or work to be conducted.

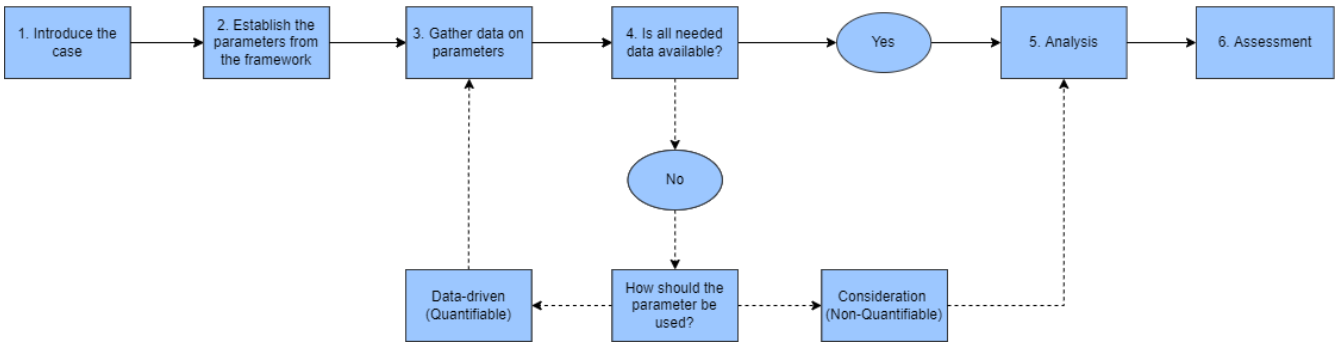


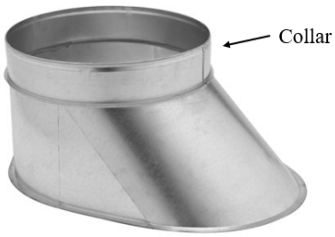
Figure 17. Process of testing the framework (Source: own figure)

6.3 Testing the framework

The result of the analysis (chapter 5) proves that change projects involving decentralization and the concern of "where to produce what" is currently of high interest and importance. Therefore, the cases used for testing the framework are chosen in relation to these aspects. This chapter applies the "Process of testing the framework" presented in figure 17 on two cases. Firstly, the "Boots case", further referred to as Case 1, and secondly the "Couplings case", further referred to as Case 2. Beyond the process of testing the framework and further developing the final framework, the result of testing the two cases will additionally give insight on further considerations and possible improvements for evaluating the parameters driving the decision in each change project. The recommendation (step 6 in figure 17) will be given as a common chapter combining case 1 and 2.

6.3.1 Case 1 Introduction

The first case relates to the UK market concerning where to produce “Boots”, also called TBS, TBSU, TBSF or TBDSU depending on the design (a boot is visualized in figure 18). The boot is a vent fitting used to create air duct systems. The boots are categorized in two dimensions, dim 63-200 and dim 224-630. Today, the bigger dimensions are produced in the UK while the small ones are produced in Prague. However, data show that 98,8% of the small boots produced in Prague are sold in the UK. That is one of the reasons for considering moving the production of small boots to the UK.



“Boot” (TBSF)

Figure 18. Case product "Boot"

Historically, the decision was made to put production of these products in Prague because of available capacity and low labor costs. The boots are so called hand-made products which means that manual labor is required and no investments in machines are needed. However, the collar on the boots is produced in machines, more specifically coupling lines. Today, the redesign option for moving the production from Prague to the UK needs to be evaluated. It is necessary to off-load the production unit in Prague since it is over-utilized and has an overtime estimated to +25% on weekdays. Due to the high overtime, the aspect of health and safety is highlighted. Overtime could cause stress which consequently lead to mistakes and injuries. The re-evaluation of where to put the production should especially be done on labor costs together with freight costs, but also labor availability. The labor availability in the UK needs to be considered since the product is a hand-made fitting. There is no need to invest in a new machine in the UK, but good hand skilled people are required to produce the boots.

6.3.2 Establishing the Parameters

After introducing the case, the parameters are discussed with a corresponding reasoning for either including or excluding a parameter in the work. As the nature of the case is considering different alternatives in regard to finding a suitable solution one must establish relevant parameters in both the aspects of evaluation on one alternative and in the aspect of comparison. The established parameters are shown in table 9 below.

Table 9. Established parameters for Case 1

Parameter	Included	Reasoning
Costs	X	The evaluation of costs is important to motivate a profitable business case, by understanding all expenses. For case 1, all costs are included except material and packaging since these are equal despite the location.
Country	X	As the case is considering two different possible country locations, one must consider the challenges and capabilities

		available at a location in regard to culture, mentality, competence levels and governmental influence
Customer service	X	Due to the possible relocation of production, all parameters included in customer service should be calculated to understand the implication of the relocation. Forecasting can accommodate with assumptions on parameters like quality and inventory availability, which does not have current data.
Efficiency*		
Health & Safety	X	As different locations are evaluated it is important to consider information on current processes, activities and strategies that can be used to control and mitigate risks for health and safety.
Investments	X	Since the case product is a hand-made product and require only manual labor, the only investment needed is education of employees.
Legal & Political	X	As the case is considering two different possible country locations one must consider the differences in regard to, development of wages, laws and consequences of political decisions like Brexit, to further understand the impact of the aforementioned
Location	X	As the nature of the case is considering different alternatives in regard to a location, one must evaluate with a comparison between possible alternatives
Measuring	X	The measuring parameters need to be calculated to understand if you are able to handle the products in an efficient way at the new location.
Productivity	X	Provides feedback in regards of whether operational changes, additional employees or additional equipment is needed to meet a given demand or goal(s)
Products	X	Since the case involves a specific product, the product specifications are important to highlight in order to understand the implications of warehouse capacity and transportation for example.
Resilience	X	To gain understanding on how a current or future solution is capable of meeting, accepting, and managing future changes and situations.
Savings	X	Similar to costs, this parameter is important to calculate in order to understand the profitability of the business case.
Sustainability	X	Contribute with assessment of environmental pollution, to help further understand the environmental impact and consequences of a chosen solution.

** Excluded. Since the products are hand-made products, requiring manual labor, there is no need to evaluate the efficiency of machinery. Additionally, the efficiency of employees is expected to be equal despite the location.*

6.3.3 Data Gathering and Availability

In the following chapter, the data gathering and data availability were evaluated relative to the data provided from Lindab. The data which was examined was available in the form of Excel sheets, including both raw data and calculated data, along with survey results in the form of charts. Table 10 shows whether data is available or not (yes/no), along with a reasoning or explanation of the evaluated availability. The two different areas considered in the case are referred to as CZ (Czech Republic) and UK (United Kingdom) in table 10 below.

Table 10. Data Availability for Case 1

Step 1		
Parameter	**Data**	**Commentary**
Costs		
Labor	Yes	Labor costs are available in the form of direct labor costs, phrased in the way of pcs per man hour and volume per year, and additionally using wages rate from both UK and CZ.
Freight	Yes	Freight costs are available in the data form of cost per cubic meter. The data is based on historical data. It is anticipated that savings will be generated for freight costs if production is moved to local.
Material	Yes	The material cost is given in the parameter of direct material cost, and is including, material and packaging costs along with the technological scarp (a percentage of the total scrap). It is anticipated that this cost will be the same no matter the location chosen in the case.
Overhead	Yes	Overhead (OH) costs are only available for the current setup in CZ, hence not enough data on OH costs from UK to compare with. However, it is anticipated that the OH costs will be similar in different locations.
Inventory	Yes	The inventory cost is expressed as the average stock. It is anticipated that this cost will be similar no matter the location chosen in the case or with relatively small difference.
Packaging	Yes	The packaging costs are included in the direct material cost.
Production	Yes	The production costs are available in the form of a sum of labor and material costs.
Alternative	Yes	The alternative cost(s) is available in the form of expected savings on overtime payments (labor cost).
Investment(s)		
Investment	No	No technological investment needed to potentially move the production. The need of resources has been confirmed by the UK facility to already be there. Hence, no additional investments in case of moving production form CZ to UK.
Savings		
Profit	No	There is not data available on profit, due to the parameter being evaluated on a higher level and not product specific.
Revenue (EBIT)	No	
Sales	Yes	The data is available in the form of Sales per item and total sales per region - sales per year, on a product specific level. Potential growth is anticipated to be impacted relative to the lead-time.
Step 2		

Parameter	Data	Commentary
Product		
Specifications	Yes	There are several data measurements regarding the product specifications, such as type of material, dimension/diameter, length, Item ID, net weight, pieces, packaging quantity, quantity on pallet etc.
Customer Service		
Delivery precision	Yes	Delivery precision is available in the form of a percentage showing order delivered within an agreed time period (lead time). Is anticipated to be impacted relative to the inventory availability.
Lead-time	Yes	Lead-time is available in the form of days, expected to decrease by 2 days if moved to UK, since the transportation from Prague will be eliminated, and production will be local relative to the market.
Quality of products	No	There is no available data, but since there are clear specifications regarding the production, the quality should remain the same. However, fewer handling points in the flow are expected if moved to UK, which possibly can improve the quality.
Inventory availability	Yes	The inventory availability is available in the form of a percentage of stock, which is available relative to orders demanded by customers. The inventory availability is expected to increase with possible local production and anticipated increase in turnover of stock.
Measuring		
Volume	Yes	It is expressed by volume per item both in quantity and cubic meters.
Capacity	Yes	The capacity is represented in the form of available employee resources and available machine hours at different locations. It has been confirmed that the UK facility has free capacity to handle the boots production line if moved.
Utilization	Yes	The utilization is available in the form of used resources and machine hours (a function of the use of the represented capacity). The facility in CZ is currently over-utilized (expressed with overtime) and the facility in UK have free capacity in terms of shifts/ labor hours. The possible change is expected to have a positive impact on the utilization in both locations.
Fill-rate of transportation mode	No	There is no exact data available, though data on a general level is available in the form of total amount of cubic meters and trucks shipped between the two locations (CZ and UK). Hence, further calculations are possible to conduct on the general data to get the exact parameter data.
Productivity		
Transactions per hour per employee	Yes	Expressed as pieces per man hour (production cycle time) and is also used to calculate the needed hours per employee (FTE).
Transportation frequency	Yes	Expressed as transports per week and will remain the same.
Environmental Sustainability		

Emissions (CO_2)	No	The data is not available on the case specific level, though general data on a higher level is available within a tool called Position Green for transport specific emissions, where distances driven (in tons kilometers) and weight of transported goods are reported. The emissions are then calculated based on the reported data relative to emission factors given in the system.
Energy consumption	No	Not available
Scrap	No	No data available as scrap is measured relative to the total production and cannot be expressed per item. Though, a technological scrap (a percentage of the total scrap) is included in the material cost parameter.
Step 3		
Parameter	**Data**	**Commentary**
Country		
Culture	No	No data available, nor a data in- house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed.
Mentality	No	
Competence levels	No	
Government	No	
Legal & Political		
Laws & Regulations	No	No data available, nor a data in-house system to extract data from, hence, depended on discussion driven decision. Anticipated that the discussion will be on topics like Brexit, availability of drivers, Russian invasion of Ukraine etc.
Wages	No	No data available, nor a data in-house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed. Though wages in CZ have shown to increase rapidly compared to the UK.
Resilience		
Flexibility	No	No data available, nor a data in-house system to extract data from, hence, depended on discussion driven decision.
Adaptability	No	
Social sustainability		
Employee satisfaction	Yes	Available data in the formatting of a satisfaction result based on a scale in a questionnaire *("how likely are you to recommend Lindab as a good place to work?"),* where employees are either considered detractors, passives or promoters relative to the given scale.
Health & Safety		
Incidents per month	Yes	The data is available, reported on a monthly basis, involving lost time injury, minor accidents, non- lost time injury, other health issues and the total amount. Though the data is representing a general level (facility) and not specifically pinpointed to just the production of boots (case 1).
LTIF	Yes	The data is available in the formatting of a result driven from the above data provided in incidents per month. Hence, LTIF is a function of the reported data in *"incidents per month".*

Ergonomics	No	No data available, nor a data in-house system to extract data from, hence, depended on discussion driven decision.
Location		
Costs	No	Not enough sufficient data available from both scenarios to compare on behalf of these exact parameters. Company must decide if there is sufficient data to compare
Emissions		
Customer service		

6.3.4 Analysis of Testing Case 1

The analysis of case 1 relative to testing the framework will be analyzed based on the different steps presented in the framework i.e., the structure of this chapter will be divided by the different steps, similar to table 10 (Data availability for Case 1).

Step 1

It was realized that several parameters are phrased differently compared to the parameters in the framework, but it is still possible to fit them properly into the defined parameters in the framework. For example, the cost of packaging is included in material cost and will not be presented with data on its own. To make the data clearer in relation to different parameters, it should be possible to express the parameters on its own, for example the packaging and production cost. Since the production cost is defined as a combination of direct labor and direct material, it is difficult to understand exactly what data that drives the production cost. Furthermore, not all emphasized quantifiable parameters are quantifiable in step 1. In case 1, the parameter of investments, profit, and revenue are non-quantifiable.

Looking at the available data in step 1, it is emphasized that some data is calculated to be the same despite the location and therefore not relevant to evaluate further. In case 1, material costs are believed to be the same and can therefore be excluded. The inventory costs are also anticipated to be similar at the different locations. The average stock will be reduced with less than £300, and the change is therefore minor that it becomes redundant. The overhead costs are also anticipated to be similar at the different locations, but since the data regarding overhead costs are only fully available in CZ, and not in the UK, it cannot be excluded. In general, all parameters in the category of costs have data available, which means that decisions made on costs could be 100% data driven. This could be seen as a good start to become data driven although some parameters are in need of clarification and further improvement.

Regarding investments, there is no technological investment needed and therefore there is no available data regarding pay-off time. However, by moving the production of Boots, the employees in the UK will need to acquire knowledge and skills for producing the products. Therefore, the investment of education needs to be considered and further calculated. Looking at the category of savings, it was expected that profit and revenue is calculated on a higher level then item specific. However, it is interesting to know if the production line of a specific product like Boots is running in positive or negative numbers. In addition, if Lindab anticipates a potential growth due to better lead time and availability gained from production in UK, then it will be even more interesting to have profit and revenue on item level.

Step 2

When analyzing step 2, it was made clear that there is data on the majority of parameters, but this is not frequently used by Lindab when calculating and evaluating different alternatives in the supply chain. Calculations made on parameters in step 1 are mainly used when evaluating a decision, while parameters in step 2 are often assumed to be “good” or “bad”.

However, looking into the different parameters separately, there is plenty of data available relative to the product specifications. This is beneficial since it simplifies the data allocation on different items. Regarding the customer service, there is also available data for all parameters except Quality of products. The data on customer service is available on item level which is beneficial for comparing different alternatives. But the missing data on quality is crucial. Just by delivering on the promised date does not automatically mean that the products delivered are of good quality. Therefore, data on quality could help Lindab to confirm whether they have a good performance or not.

Looking at the category of Measuring parameters, all parameters except fill-rate of transportation mode has data available. However, data can be found regarding total volume shipped between CZ and the UK, and the available cubic meters in a truck. The fill rate is though assumed to be similar despite the location, but this should be confirmed with data. Since there is data that potentially could be used to calculate the fill rate, it is possible to actually confirm and validate the anticipation with data. In terms of capacity, it is also important to highlight that in this case, considering hand-made products, the capacity is connected to competence level. Just because there are available resources and capacity in terms of employees, they also need to have the right knowledge and skills to perform the tasks. In general, it was learned that Lindab has more understanding on capacity of machines rather than resources like humans.

Furthermore, Productivity has data on both transaction per hour per employee and transportation frequency. The transportation frequency is calculated to be the same no matter the location and could therefore be excluded in further calculations and comparisons. In general, the change project is not about improving productivity, only moving production hence the same set-up. Meaning that the productivity should be the same despite the location. However, one must consider the possible difference in knowledge and skills among employees at the new location. The employees might not be familiar with the production line which therefore may affect the productivity. Though, on a long term, the skills and knowledge will be equal and thereby also the productivity.

Regarding Environmental sustainability, it was realized through the interviews that this category of parameters is one of the most important. However, the data regarding Emissions (CO_2) and Energy consumption is vague and not clear among different employees. This parameter has gained importance the last couple of years and is therefore relatively new. Consequently, there is not much data gathered in relation to environmental sustainability. However, Lindab is working with a tool called Position Green that calculates emissions. The distances driven in tons kilometers and weight of transported goods are reported into the tool which then calculates emissions along with emission factors. This data is given on a general level and hard to transmit to a specific department and change project. It was also learned that this is not communicated among employees and there is no clear structure on how to use it in decision making.

Step 3

When looking at step 3 in relation to testing of case 1, it was acknowledged that the majority of the parameters were as expected in nature non-quantifiable parameters. Hence, Lindab was not able to provide data on specific parameters, specifically the Country, Legal & Political, Resilience and Location parameters were with no data availability. What all of these parameter categories have in common is the unavailability of data nor a data in-house system to extract

data from. Meaning the Lindab organization itself are not able to provide expertise on this matter, hence the knowledge and discussion in relation to these parameters must be considered with help of a standardized outsourced database or resource. Additionally, the parameter of Location is in nature a comparison parameter of other parameters, hence is depended on the availability of other parameters. As the parameters of which location is depended on does not have available data nor can the location parameter be deemed quantifiable. Though it can be argued that the Location parameter can be a comparison of any of the parameters, as long as the same data is represented for each scenario (in this case a CZ and UK setup). Hence, one can decide relative to what is important in a given case, what one chose to compare among different scenarios, on not choose to compare at all.

Opposite, the parameter of Social sustainability showed to some extent to have a quantifiable measure, in the form of a satisfaction questionnaire for employees. Though this questionnaire is on behalf of the question "*how likely are you to recommend Lindab as a good place to work?",* hence can be augmented not to represent an organizations full picture of social sustainability, but more on an overall level. Moreover, no data was available on ergonomics in relation to social sustainability. Hence, the full sustainability picture cannot be acknowledged with a missing aspect affecting employees everyday work life. Additionally, the parameters of Health & Safety showed to be in majority of quantifiable measures, as Lindab in fact monitor and quantify both incidents per month and lost time incident frequency. Though it is in a quantifiable manner, one must still consider it of having some discussion in nature, as a number of incidents in itself does not give much insight unless it is put relative to something. Additional to the LTIF it was acknowledged that it is rather used as an indicator than an accurate measurement. Meaning, LTIF is based on some measurements, like number of employees or the hours worked at a specific production line and in theory makes it most suitable for comparison if the comparable option(s) is represented with approximately the same measurement, again as an example number of employees or the same amount of hours.

To sum up, the majority of the parameters are as expected in the nature of non-quantifiable measures, hence no data availability. Though all parameters are considered important relative to evaluating the case, meaning no parameters are excluded, as they can be accepted as non-quantifiable and bring knowledge to the case in that nature. Approximately 66% of the parameters are within the non-quantifiable, meaning that step 3 on majority will not be discussed and extract decisions which are data driven. Though as the step 3 comes with the acceptance of possibly having it sorely depend on non-quantifiable parameters, the result is not surprising nor considered bad. Opposite in relation to the future goal of having more and more data driven solution, one must further investigate how non-quantifiable parameters can be handled in a quantifiable matter. One thing that was highlighted multiple times when doing the data gathering was the possibility of placing the non-quantifiable parameters on a standardized scale or similar approach. Developing this scale is deemed as a very valuable future task, though is not in the scope of this master thesis work, as it is believed to require in-depth knowledge and work to develop such a consistent scale for non-quantifiable parameters. Hence, is highly recommended as it will increase the data driven nature of a decision.

6.3.5 Case 2 Introduction

The second case concerns where to produce couplings for the UK market. Couplings are a product that are made to connect ducts, see figure 19. There are two different types of couplings, one called MF that is used to push a fitting inside, meaning that the coupling is outside the duct, while the other one called NP is used inside the duct which means that the duct overlays the coupling. The purpose of the change project is to evaluate whether to invest in a new machine

for couplings in the UK or make the investment at the central unit in Prague and thereafter ship couplings to the UK.

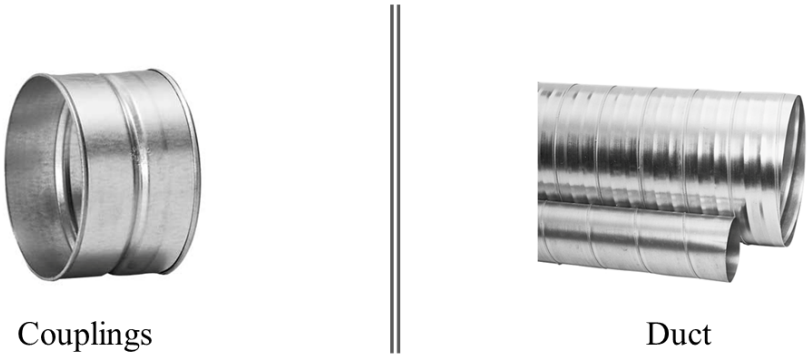


Figure 19. Case products: Couplings and Duct

There are different production lines that produce different dimensions of couplings. This case considers couplings of the dimension category 100-315. Today, Lindab have a simple technology set up for MFs and NPs in the UK. This includes a manual welding process followed by a simple machine performing the forming process. But in the category of 100-315, only the dimension of 200 and upwards has been produced since this was the breakeven point when the production was set up in the UK. The essence of the problem is whether Lindab is competitive with the smaller dimensions today (the total range of dim 100-315), and therefore should invest in a new machine. Either way, having a growth, they need to invest somewhere. This means that Lindab needs to decide if the production of couplings, dimension 100-315, should be produced locally in the UK or at the central unit in Prague.

Comparing the set-up in UK to the central production in Prague, the main difference is cycle time. The central unit can produce couplings twice as fast compared to the local unit. However, there are several potential benefits of investing in a new machine in the UK instead of shipping the products from Prague. There are potentially local savings that could be made but also savings on the environment. By reducing the transportation from Prague to the UK, they reduce the environmental footprint. Furthermore, external factors as customs due to Brexit is another factor that needs to be taken into consideration when evaluating the decision.

6.3.6 Establishing the Parameters

After introducing the case, the parameters are discussed with a corresponding reasoning for either including or excluding a parameter in the work just like it was done in the matter of case 1. The established parameters are shown in table 11 below.

Table 11. Established parameters for Case 2

Parameter	Included	Reasoning
Costs	X	The evaluation of costs is important to motivate a profitable business case, by understanding all expenses.
Country	X	As the case is considering different possible country locations, one must consider if challenges and capabilities available at a location in regard to culture, mentality, competence levels and governmental influence
Customer service	X	Due to the possible relocation of the production, it is important to calculate and understand the implication of the change in relation to customer service.

Efficiency	X	Since one of the main differences in the set-ups is the cycle time, it is important to calculate the overall equipment efficiency.
Health & safety	X	Contributes with information on current processes, activities and strategies that can be used to control and mitigate risks for health and safety. As many different activity types is conducted in this case (manual work, machinery, co-botics), hence increase the complexity of a healthy and safe work environment.
Investments	X	Since this case especially evaluates the possibility of investing in a new machine, it is important to calculate the breakeven point and utilization of the investment.
Legal & Political	X	As the case is considering different possible country locations one must consider the differences in regard to, development of wages, laws and consequences of political decisions like Brexit, to further understand the impact of the aforementioned
Location	X	As the nature of the case is considering different alternatives in regard to a location, one must evaluate with a comparison between possible alternatives, specifically if there is acquired more benefits from moving the production
Measuring	X	The measuring parameters need to be calculated to understand if you are able to handle the products in an efficient way at the new location.
Productivity	X	Provides feedback in regards of whether operational changes, additional employees or additional equipment is needed to meet a given demand or goal(s). Specifically in regard to whether the productivity is higher than the actual demand of couplings and vice versa. Hence, unnecessary productivity resulting in high stock levels.
Products	X	The product specifications are important to highlight in order to understand the implication of producing a certain dimension in the UK.
Resilience	X	To gain understanding on how a current or future solution is capable of meeting, accepting and managing future changes and situations.
Savings	X	This parameter is important to calculate in order to understand the profitability of the business case.
Sustainability	X	Contribute with assessment of environmental pollution, to help further understand the environmental impact and consequences of a chosen solution.

6.3.7 Data Gathering and Availability

In the following chapter, the data gathering and data availability were evaluated relative to the data provided from Lindab. The data which was examined was available in the form of Excel sheets, including both raw data and calculated data, along with survey results in the form of charts. Table 12 shows whether data is available or not (yes/no), along with a reasoning or explanation of the evaluated availability.

Table 12. Data Availability for Case 2

Step 1		
Parameter	**Data**	**Commentary**
Costs		
Labor	Yes	Labor costs are available in the form of direct labor costs, given in the form of operation time required relative to the wages and pieces per hour for a given machine.
Freight	Yes	Freight costs are available in the form of cost per cubic meter for most ventilation products or depended on the weight for heavy products.
Material	Yes	Available in the form of direct material, presented in either the price of square meters or kilos of a given material.
Overhead	Yes	Overhead costs are available for different setups at different locations on a product specific basis.
Inventory	Yes	The inventory cost is expressed as the average stock. It is anticipated that this cost will be similar, or with a relatively small difference, no matter the location chosen in the case.
Packaging	Yes	The packaging costs are included in the direct material cost.
Production	Yes	The production costs are available in the form of a sum of labor and material costs.
Alternative	Yes	The alternative cost is represented in the form of the difference in costs (savings, production etc.) for different possible scenarios/solutions.
Investment(s)		
Investment	Yes	The data is available in the form of considering a possible investment amount relative to anticipated pay off time and the depreciation of a given investment.
Savings		
Profit	Yes	The data is available in the form of Net Savings on a product specific level.
Revenue (EBIT)	No	There is not data available on profit, due to the parameter being evaluated on a higher level and not product specific.
Sales	Yes	Sales per item and per year on a product specific level.

Step 2		
Parameter	**Data**	**Commentary**
Product		
Specifications	Yes	There are several data measurements regarding the product specifications, such as type of material, dimension/diameter, length, Item ID, net weight, pieces, packaging (box/pallet) quantity, quantity on pallet, weight, BOM, drawings etc.
Customer Service		
Delivery precision	Yes	Delivery precision is available in the form of a percentage showing order delivered within an agreed time period (lead time). Anticipated to be the same no matter the location.
Lead-time	Yes	Lead-time is available in the form of days, expected to decrease by 7 days if moved to UK, since the transportation will be local relative to the market.

Quality of products	No	No data available but there is awareness about complaints on units, meaning a small amount of data on non-confirmative products are there but the data is not handled.
Inventory availability	Yes	The inventory availability is available in the form of a percentage of stock, which is available relative to orders demanded by customers. The inventory availability is expected to increase with possible local production.
Measuring		
Volume	Yes	The data is available in the form of volume per item, hence product specific. It is anticipated that the demanded volume does not meet a level to satisfy a profitable investment of new machinery.
Capacity	Yes	The capacity is available in the form of a function between available up time of machinery relative to how many cycle times can be conducted within that up time. Hence, how many products can theoretically be produced equals the capacity.
Utilization	Yes	The utilization is available in the form of shifts (represents the machine hours in a shift), needed for a specific production type: hand-made, semi-automatic or automatic-line, relative to the capacity available for a given production line.
Fill-rate of transportation mode	No	There is no exact data available, though data on a general level is available in the form of total amount of cubic meters and trucks shipped between the two locations (CZ and UK). Hence, further calculations are possible to conduct on the general data to get the exact parameter data. The shipped volume is believed to be the exact same, though possibly transported/shipped from a new location (in UK), hence same fill-rate on different trucks.
Efficiency		
Efficiency of machinery	Yes	Data available in the form of a calculation on the OEE - overall equipment efficiency, resulting in a percentage. It is anticipated that the efficiency will be the same no matter the location, though the productivity/speed is believed to decrease if moved to UK due to different set ups of resources and machinery.
Productivity		
Transactions per hour per employee	No	No data available in connection to the coupling case (product specific), though data is available on a higher level for specific warehouses but is not anticipated to contribute to the analysis.
Transportation frequency	Yes	Expressed as transports per week and will remain the same.
Environmental Sustainability		
Emissions (CO_2)	No	The data is not available on the case specific level, though general data on a higher level is available within a tool called Position Green for transport specific emissions, where distances driven (in tons kilometers) and weight of transported goods are reported. The emissions are then calculated based on the reported data relative to emission factors given in the system.
Energy consumption	No	Not available.

Scrap	No	No data available as scrap is measured relative to the total production and cannot be expressed per item. Though, a technological scrap is included in the material cost parameter.
Step 3		
Parameter	**Data**	**Commentary**
Country		
Culture	No	No data available, nor a data in- house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed.
Mentality	No	
Competence levels	No	
Government	No	
Legal & Political		
Laws & Regulations	No	No data available, nor a data in- house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed. Anticipated that the discussion will be on topics like Brexit, availability of drivers, Russian invasion of Ukraine etc.
Wages	No	No data available, nor a data in- house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed Specific wage rates are available, but not a reflection on those.
Resilience		
Flexibility	No	No data available, nor a data in- house system to extract data from, hence, depended on discussion driven decision. Out-sourced services/databases needed.
Adaptability	No	
Social sustainability		
Employee satisfaction	Yes	Available data in the formatting of a satisfaction result based on a scale in a questionnaire *("how likely are you to recommend Lindab as a good place to work?"),* where employees are either considered detractors, passives or promoters relative to the given scale.
Health & Safety		
Incidents per month	Yes	The data is available, reported on a monthly basis, involving lost time injury, minor accidents, non- lost time injury, other health issues and the total amount. Though the data is representing a general level (facility) and not specifically pinpointed to just the production of couplings (case 2).
LTIF	Yes	The data is available in the formatting of a result driven from the above data provided in incidents per month. Hence, LTIF is a function of the reported data in *"incidents per month".*
Ergonomics	No	No data available, nor a data in-house system to extract data from, hence, depended on discussion driven decision. It is though anticipated that ergonomics could be evaluated with the use of risk analysis related to different production lines.
Location		
Costs	No	Not enough sufficient data available from both scenarios to compare on behalf of these exact parameters. Company must decide if there is sufficient data to compare.
Emissions		
Customer service		

6.3.8 Analysis of Testing Case 2

The analysis of case 2 relative to testing the framework will be analyzed based on the different steps presented in the framework i.e., the structure of this chapter will be divided by the different steps, similar to table 12 (Data availability for Case 2).

Step 1

Analyzing step 1 in case 2, we can see that 11 out of 12 parameters have available data. Since decisions, historically, has mainly been made based on costs, it was expected that the majority of the cost parameters would have available data. However, all cost parameters are not strongly represented in relation to the framework, similar to case 1. For example, packaging and production costs are included in direct labor and direct material and cannot be expressed on its own. To improve the cost breakdown structure, Lindab should provide data on each parameter separately to get a deeper understanding of the representation of different parameters. Looking at some cost parameters separately, it can be stated that the inventory cost will have a minor reduction of £100 which makes it redundant to consider further. Moreover, in this case, the alternative cost is expressed as the two different alternatives considered in the change project. Meaning, either what the cost will be for investing in a new machine in the UK or alternatively in CZ.

Regarding the investments, this is a crucial parameter since the change project is dependent on if the investment case is beneficial or not in terms of pay-off time and depreciation. Therefore, it is important to consider the investment relative to the anticipated volume. The investment will not be beneficial if the volume is too low in the UK. In general, the investment parameter can most likely be seen as the central parameter in this case since the decision will come down to if it is a good investment case or not.

Different from case 1, data on profit, also expressed as net savings, is available in this case. For case 2 it is important to evaluate this parameter on a product specific level since all dimensions in the category of 100-315 are not produced today. Accordingly, it is important to evaluate the difference from the historical decision, that only dimension 200 and upwards should be produced, and the current situation i.e., if it is profitable to produce the lower dimensions as well.

Step 2

When looking at step 2 in relation to testing of case 2, firstly it was acknowledged that the majority of the parameters were in fact with availability of data, more specifically approximately 78 % of the parameters. The first category of product specifications was with sufficient amount of available data, hence all needed specifications were covered with data for that parameter.

Next, the customer service was in majority of available data, though as also seen in case 1, the quality of products was missing available data. It was argued from an employee that the organization did in fact have knowledge about that data would be available for this matter but that the data was simply not gathered or handled, hence deemed not available. As the nature of measuring quality will contribute with a transparency of what is actually produced with success relative to the expectations, it would be crucial to get data on that parameter in the future. Additionally, as the remaining parameters does not measure the quality of customer service but rather parameters contributing to the productivity of a process, hence that quality parameters would contribute to confirming whether the processes are actually done in a benefit manner and not just rather if it is done within time or not.

Furthermore, the parameter category of Measuring was in majority also with available data, both the volume, capacity and utilization were with clear definitions, data sets and explanation of calculation. Opposite, the fill-rate of transportation mode was not with any available data on a project specific level, though data on a general level were available in the form of total amount of cubic meters and trucks shipped between the two locations (CZ and UK). Hence, further calculations are possible to conduct on the general data to get the exact parameter data, though as it is anticipated that the same amount of products are shipped no matter the location, the missing data is not considered crucial for the decision. Though obviously confirming an anticipation with corresponding data, would have strengthened the reasoning for deeming it non-crucial.

Additionally, the parameter of efficiency of machinery showed data availability in the form of a calculation based on Overall Equipment Efficiency (OEE), which generate a very standardized approach to measuring efficiency. Hence, a suitable efficiency parameter for being data driven. When looking at the parameters of productivity, no available data for a number of transactions relative to either workers or processes were available on a product specific level for the case. However, the data was available on a more general level, but not in a form of which it was believed important for the case, as it was not anticipated to contribute further to the case analysis. Opposite, data was available for transportation frequency, expressed as transports per week and was anticipated to remain the same no matter the location. Hence, further investigation can be done to confirm this anticipation, as the frequency in itself does not contribute with much if it is not looked at in relation to quality of the frequency. Or the parameter could be deemed excluded it the anticipation is deemed of high accuracy.

Lastly, the parameters of environmental sustainability, were deemed to show no available data, though it was shown that there was in fact a system for transportation emission (as in case 1) of which employees report weight and ton kilometers, used to calculate emissions with corresponding emissions factors. These emission data where though managed and handled on such a high level, making it difficult to adapt to a specific case (like the couplings case). Hence the availability of data is there on a high level, but not with the adaptability and transparency to be used case or product specific. Having data on these parameters closer to different production lines or units could have contributed with a strong insight and knowledge on the environmental footprint of which this specific production is a part of, and to which extent it is affecting the general sustainability picture. However, the parameters are argued to still be relatively new for several industries, meaning a lot of work is still needed to learn how to handle, measure and define those parameters on different levels.

In conclusion, step 2 in case 2 can in majority be driven by good data inputs and contribute to an overall data-driven solution, though one should always strive to cover missing parts with data as well, and not just satisfy with current data availability. In connection to this, as much data is in fact available in the step 2, one should consider letting those parameters be of higher importance when making a decision.

Step 3

When looking at step 3 in relation to testing of case 2, it was shown that the majority of the parameters were as expected in nature non-quantifiable parameter just as for case 1. The picture of data availability was in fact the same as experienced in case 1. Hence, Lindab was not able to provide data on specific parameters, specifically the Country, Legal & Political, Resilience and Location parameters were without data availability. Meaning no data availability and nor a

data in-house system to extract data from. As discussed in case 1, there is a need for an expertise on the parameters and a standardized way of working with the non-quantifiable parameters in the future. Additionally, as in case 1 the parameters of Location are in nature a comparison parameter of other parameters. Though it can be argued that the Location parameter can be a comparison of any of the parameters, as long as the same data is represented for each scenario. Hence one, can once again decide relative to what is important in a given case, what one chose to compare among different scenarios, or not choose to compare at all.

Moreover, the parameter of Social sustainability showed to some extent to have a quantifiable measure, in the form of a satisfaction questionnaire for employees ("*how likely are you to recommend Lindab as a good place to work?"*). Hence, the exact same as argued for in case 1 and is also here augmented not to represent an organizations full picture of social sustainability, but more on an overall level. Moreover, just as for case 1, case 2 showed no data for the parameters of ergonomics. Lastly, when looking at the Health & Safety it once again showed to be in majority of quantifiable measures, as Lindab in fact monitor and quantify both incidents per month and lost time incident frequency (LTIF), in the exact same matter of which was explained in case 1. Moreover, just as explained in analysis of case 1, one must consider the scenarios of which the LTIF might be used to compare, hence rather that the data used for calculating the LTIF is in fact comparable or misleading.

To sum up case 2, the majority of the parameters represented in step 3 were as expected non-quantifiable parameters, specifically approximately 66%. All of the parameters are though still considered important for discussion matters on the case and thereby non is excluded. As argued for in case 1, a result of a majority of non-quantifiable parameters were not a surprising result due to the nature of the parameters, being rather discussion driven. In this connection it was once again highlighted the need for further investigating how non quantifiable parameters can be handled in a quantifiable matter, hence the use of a scale as mentioned in case 1, though the development of such scale is once again deemed out of the scope of this thesis work and must be considered as future work.

6.4 Assessment of Testing

In the following chapter, an assessment is done for the procedure of testing, corresponding to step 6 in figure 17, with the purpose of understanding the outcome of testing both the cases and the framework in general.

6.4.1 Case Assessment

In general, for further development and great use of the framework, recommended future work was acknowledged when testing the framework on case 1 and 2. Firstly, looking at the aim of the framework helping with generating data driven decision, it was shown that one should to some extent understand the degree of which a data driven decision was established from the framework, hence on which percentage is a decision data-driven and is it an accurate assumption. When gathering data for case 1, it was evaluated that there was data available for 21 out of 39 individual parameters (Efficiency parameter excluded), hence a data availability of approximately 54% and for case 2 the data was available for 22 out of 40 individual parameters, hence approximately 55% data driven. Though this is indicating that a lot of data is actually available and even the majority has corresponding data. It was also learned through testing, that an evaluation like that can to some extent be misleading and less critical towards if data is actually available. Meaning, having data available on something does not automatically result in data being useful or of good representation of a parameter. As an example, which was also mentioned in the analysis of the different steps, several parameters do have data but in the

form of a more general setting than production line specific as mentioned both in table 11 and 12 on data availability as well. Hence, it can be argued that there is no guarantee that a global understanding and representation of master data of a parameter, directly represent the same parameter on a product/production line level in a good manner. Hence, the percentage of somewhat data driven can be misleading, it is though empathized that some data is better than no data, but relative to the framework it is recommended to have data available as close to the processes of question as possible, in this case the production line of boots and couplings. Hence, it is further recommended to strengthen the master data with gathering data of more local nature, to further optimize the framework and the data analysis it provides.

Additionally, when testing it was learned through the different gathered data, that even though much data was available, there was still a tendency to mainly work with the parameters of which historically drove decisions, hence primarily the cost parameters. In general, it was acknowledged that several parameters in step 2 have available data, but it is not used, or known, by the employees when evaluating different decisions. To develop in a more data driven direction, it is recommended to further investigate the use of additional parameters to be of importance in a decision, meaning not just having the data but actually making it count in a possible decision. For doing this recommendation it was acknowledged through testing that additional work needs to be done in terms of understanding the different links between different parameters within the different categories. As an example, understanding how the different parameters of Customer service interlink and affect each other, hence to have a better understanding of how different parameters act in a given decision making.

Lastly, the testing, as expected, showed very little data available in step 3 of the framework, the ones considered non-quantifiable in nature. Even though that was an expected result, it was also learned that a standardized way of working with non-quantifiable parameters were highly recommended, hence to include them to some extent. A way of such handling was discussed to be of possible scale form. Meaning the non-quantifiable parameters would be allocated a score on a scale much like the risk matrix (which Lindab also works with on a general basis). As that can give specific scores to compare in a discussion of the parameters. In connection to this, as also learned from general data gathering it is highly recommended that if a scale is chosen to represent non-quantifiable parameters, a consistency and some standardization is needed to provide a good scale. Hence, to avoid having different departments basing the parameters on different databases and understanding of how something is scored.

6.4.2 Framework Assessment

Summarizing the testing process, some assessment and analysis can be made regarding the framework in general. Firstly, it was realized that parameters in the framework categorized as “quantifiable” and “non-quantifiable” are not fully represented as anticipated. Meaning that some parameters categorized as quantifiable are non-quantifiable due to lack of data. Structuring the framework in quantifiable and non-quantifiable is although still relevant in order to distinguish between measures naturally driven by mathematical calculations and qualitative measurements. This will give a better understanding of what parameters that theoretically should have available data. Secondly, it was made clear that data is available in many formats and do not perfectly match the parameters in the framework. This makes the process of gathering and understanding data more complex, but it is still possible to identify data for several parameters. In connection to this, it was also realized that some parameters have stronger master data than others. In case 1 and 2, parameters like production cost, packaging cost and employee satisfaction, are identified with data, however, the data is to some extent vague. This could be misleading when identifying data as available for a certain parameter. For

example, Employee Satisfaction is only based on one question and could therefore be misleading to use in a general sense. To further improve data, it is important to understand what is available, how strong it is, and how is it able to be improved in relation to its' purpose.

Data is also available in formats relative to a "higher" level rather than on "item" level. When using the framework to evaluate specific products it would be valuable to have data on an item level to provide a better comparison of alternatives. It was also understood that parameters could be defined differently on group level and local levels. In general, it is important to be aware of these differences when communicating different parameters but also to be consistent when gathering the data. Additional to that matter, a conflict was seen in the way of which the data was available to collect. The data is coming from multiple databases, employees and in multiple formats. Meaning there is no standardized way of collecting the data for an employee of which is doing a change project. Gaining more transparency and access between different employees and departments could help ease the data collecting phase, hence open the possibility of having additional parameter's data driving the decision, rather than being limited to somehow only the employees involved in a change project of question.

Looking at some specific parameters, it was understood that Environmental Sustainability is established to be a new parameter, and therefore data is only available to some extent, consequently difficult to evaluate although this parameter is considered highly important by Lindab. Since the parameter is in an early stage of data availability it could be considered that it is too early to fit into step 2 and better suited in step 3. When evaluating the parameter Health & Safety, it could be argued that this is better suited in step 2 since both Injuries per month and LTIF are quantifiable. Lastly, the parameter Location is a good representation and mix of costs, emissions, and customer service, but in theory it could include further sub-parameters, like Legal & Political, since every change project is unique relative to the case and comparison investigated.

6.5 Framework Summary and Modification

Based on the learnings from both the workshop and testing process it is was learned that some modifications to the framework were needed to strengthen the use and output of the framework. In the following table 13 below, the modifications are described relative to the different parameters in which they are represented.

Table 13. Final changes made to the framework based on both the workshop and testing

Parameter	Change	Reasoning
Efficiency	"Warehouse processes" in Efficiency is removed.	It was emphasized that the parameter would be covered with the OEE (overall equipment efficiency).
Environmental & Social Sustainability	Distinguished between environmental and social sustainability.	The name of each category was changed to clarify the different parts of sustainability (social and environmental).
Environmental sustainability	Sub-parameter "Transport distance" was removed and "Scarp" was added as a sub-parameter.	"Transport distance" was emphasized to automatically be included in the sub-parameter "Emissions" and "Scrap" was highlighted as an important representation of environmental sustainability.
Health & Safety	Combined "health" and "safety" as one category with additional parameters (LTIF and ergonomics).	Health and safety are often mentioned together. Additionally, having safety as one quantifiable measure does not tell much. The parameters considered relative to each other provides more information then individually.
	The parameter "Health & Safety" was moved to step 2-quantifiable, Phase 1.	The majority of the sub-parameters evaluated showed data availability, hence was deemed quantifiable.
Investments	Sub-parameters "Cost of investment" and "Pay-off time" were added	To better represent the aspects of investment(s) of which the parameters should consider.
Location	Removed from the framework	The essence of the parameter represents the general contribution of the framework. Hence, to compare different parameters, meaning it is a natural step and redundant to empathize as a parameter on its own.
Product	"Material" was removed from Product specifications.	The parameter is covered by the parameter "material costs" and therefor considered redundant.
	Renamed to "Product", and specification was moved to become a sub-parameter.	Due to accommodate that the specifications of a product likely being several different measures relative to the product.
Productivity	"Transaction per hour per employee" changed to "Productiveness of a process".	To represent a more general approach to productivity for a given project and accommodate that several data formats could represent the parameter relative to the case of question (e.g. transactions per employee or pieces per man-hour).
Resilience	"Flexibility" and "adaptability" were grouped into one category named resilience.	It was emphasized that the definition could be made more general. Additionally, the parameters considered relative to each other provides more information than individually.
Social sustainability	"Ergonomics" was moved from Health & Safety to Social Sustainability.	Ergonomics have similar evaluation processes as employee satisfaction. Hence, depended on subjective questionnaires.

7. The Final Framework

Based on the modifications identified in the testing and development process, the final framework has been created, presented in figure 20. Like the first version, the framework approach and logic has remained the same, dividing the framework into phase 1 and phase 2 of quantifiable or non-quantifiable parameters further divided into step 1, step 2, and step 3. The definition of each parameter is provided in Appendix 2. For further explanation on the framework logic, see chapter 6.1.

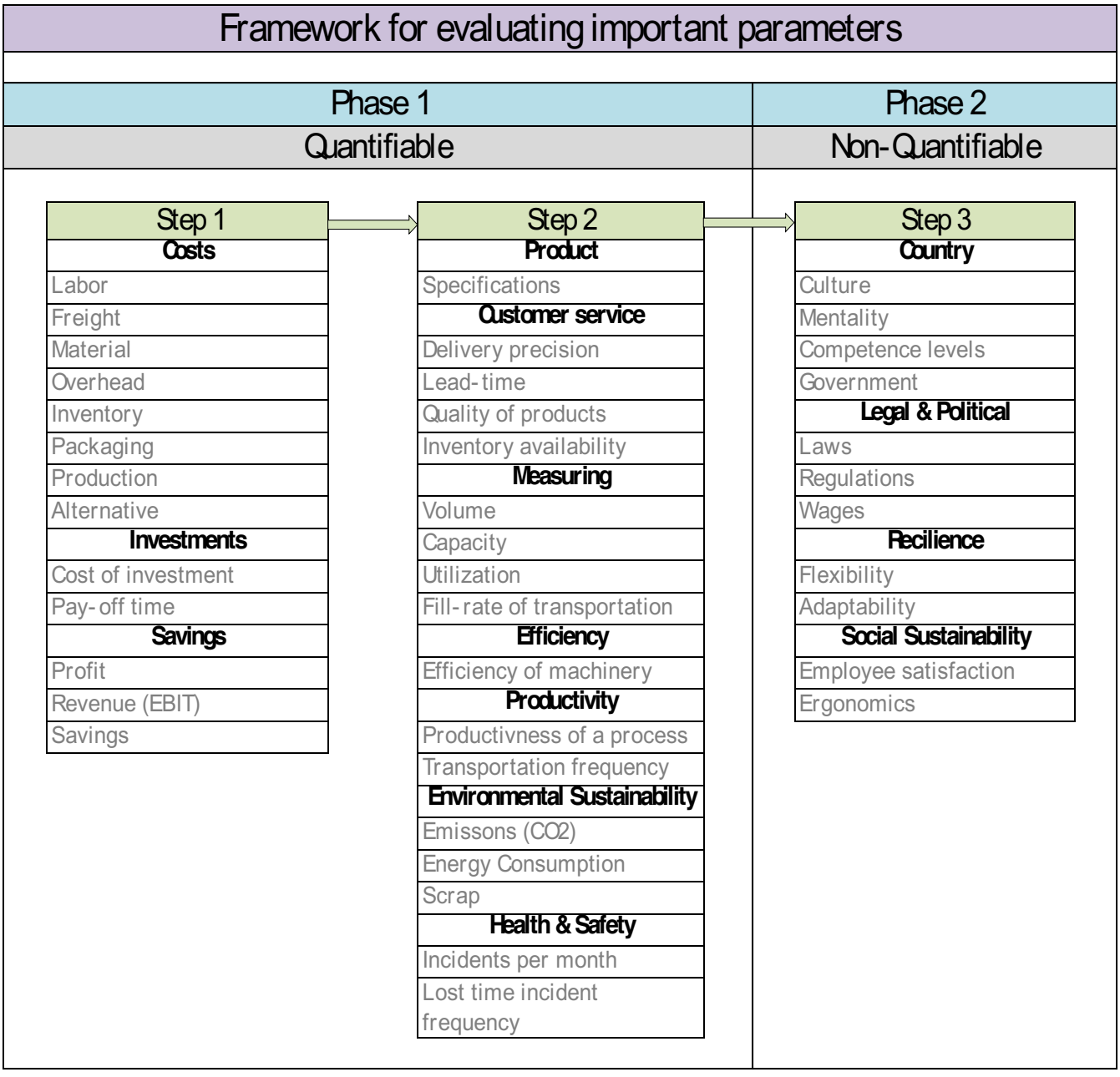


Figure 20. The Final Framework

As the testing process was structured in chapter 6, it was acknowledged that this method also is appropriate to be used as the method for using the framework, presented in figure 21. However, the last step, step 6 is named *Recommendation* instead of *Assessment*. The reason for naming it Recommendation in the process of using the framework, is because you evaluate an actual decision, which you want to provide a recommendation about, and not an evaluation of the actual framework as the purpose was in chapter 6.

An important aspect to highlight is that the framework is developed as a decision-making tool where the gathered data itself does not automatically provide any results. It is important to do a cross-case analysis to understand how different parameters are affected relative to others. Figure 21 is provided as a preferable structure to use the framework. For further understanding of the different steps in figure 21, see chapter 6.2.

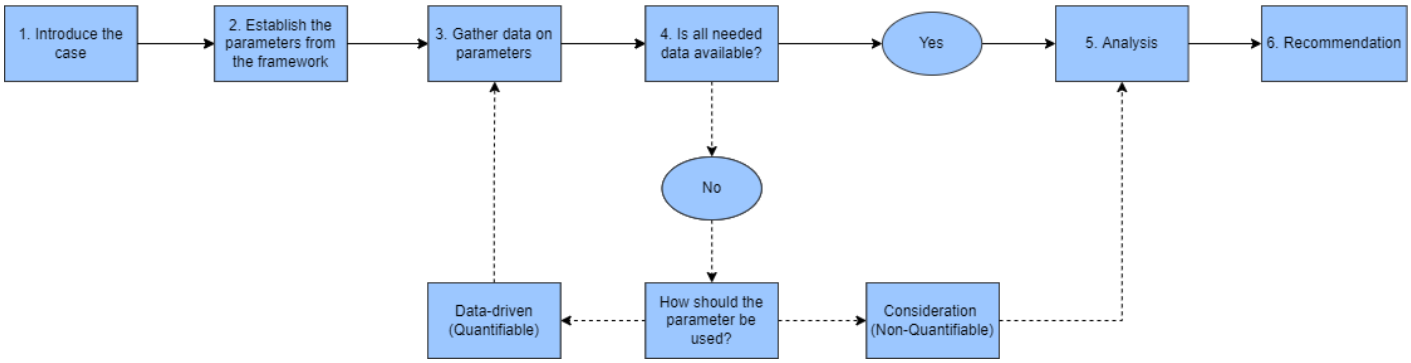


Figure 21. The process of using the framework

8. Discussion

This chapter discusses the generalization of results, the limitations of the framework, and recommended future research and usage of the framework.

8.1 Generalizations of Results

This thesis was created as a single case study, studying Lindab's supply chain network. Based on the 16 interviews, different functions and perspectives of the supply chain are included in the study which increases the practicability of the framework for Lindab. Since the thesis is created for Lindab, the results may be biased relative to the interviewed candidates from Lindab. However, the interviewed employees possess high positions in the organization and a great knowledge of supply chains.

Even though the thesis was written for Lindab, the findings can be useful for any company interested in evaluating important parameters in their supply chain network, especially manufacturing companies in the same industry as Lindab. The framework could be seen as industry specific, based on Lindab, but the framework could easily be modified to include further parameters or reduce certain parameters. The framework is developed with the purpose to be general and not focus on specific parts of the supply chain. Accordingly, the framework can be seen as a foundation and collection of important parameters, based on both recent research and industry specific insights, that should be evaluated in relation to redesigning the supply chain.

8.2 Limitations of the Framework

As the scope of the thesis was to identify important parameters in relation to changing the supply chain network, a number of parameters has been presented in the final framework. However, the process of scoping the parameters can be seen as a limitation of the framework since parameters can be found in infinity depending on the requirements. The time frame of reviewing literature could have been extended and by that, additional parameters of importance could have been identified. It is important to understand that other parameters could have been identified, but in the scope of time, it would not have been realistic for the authors to put more time into this process – which therefore is a limitation of the work. Another limitation of what parameters that are included in the final framework is the target level of ≥30% from the empirical data, hence 30% or more of the candidates have mentioned the parameter to be important. If the target level of importance would have been set to a higher or lower level, the result of the final framework would also have been different. The essence is that additional parameters could have been included in the final framework, but it is important to limit the framework to make it manageable.

A framework that is too comprehensive and complex, will complicate the understanding and usage of the framework. Even though parameters could be found in infinity, it is important to limit the framework to make it useful. The final parameters in the framework are considered equally important by the authors, but in real life this will most often not be the case since some parameters are of nature more prioritized than others in an organization. Furthermore, each change project is unique and will involve different parameters of importance. Therefore, all parameters in the framework will potentially not be included when evaluating decisions.

8.3 Research Contribution

The main contribution from this thesis, is the developed framework that can be used when evaluating different parameters relative to a change project in the supply chain. Since frameworks in research regarding which parameters that should be taken into consideration when doing a change is limited, this thesis is provided as a contribution to fill that gap. Furthermore, the thesis is confirming current knowledge but also creating new knowledge based on the collaboration between industry and literature. The pattern matching made through the analytical comparison between theoretical findings and the empirical data can be seen as a contribution to theory.

The thesis also contributes with knowledge on data availability at Lindab relative to the different parameters. As Lindab, and other companies, are aiming to become data driven, the framework can be seen as a starting point of how to approach data-based decisions and solutions. The framework will enable Lindab to better decision making and understanding of the supply chain footprint of the decisions they are making. An understanding which shall contribute to the very start of the long-term goal of integrating a digital twin of Lindab's business. This aspect is relevant for any company interested in becoming data driven and further proceed into integrating a digital twin.

8.4 Future Research

In general, when developing a framework or other helpful tools, the framework itself does no change anything. Meaning the use of it needs to be prioritized and understood to benefit from having it. Hence, the future use of such a development is to use it on various projects among the organizations, introduce it to employees with the corresponding benefits and insights from using it. Hence, the benefits of using data driven parameters to accomplish smarter decision-making. Additionally, the framework highlights a high variety of parameters that has not historically been prioritized in change projects at Lindab. So, one must also acknowledge and be open to the tooling of which the framework consists of. Meaning it must be empathized in clear manner why the framework will be helpful and not just an additional mandatory work task. Otherwise, one will not benefit from having developed it in the first place. Moreover, a framework consisting of both quantifiable and non-quantifiable measures are not static and neither is the environment of which Lindab operate their business. Thereby, the framework must be constantly developed and refined to fit the projects of change pursued at Lindab.

When it comes to future research in the relation of the framework contributing to the future development of a digital twin, several things must be considered in order to make it useful in this manner. Firstly, as mentioned above, it must be understood that the framework should never be considered static, as it should develop correspondingly to the surroundings development. Moreover, a corresponding master data profile and quality of the data to the parameters must be developed in order to use it for contributing to a digital twin. Hence, if one wish to make choices and decisions based on data, one must secure that the data used is accurate and of good quality. Additionally, the data must be formatted and arranged in a way of which different parameters data are able to be seen in comparison of each other. Meaning some parameters might not give much information without being relative to another parameters data, hence the relationship between parameters must be developed to represent the real world scenario (the digital twin). In connection to that, a general next phase can be empathized for Lindab to approach following this master thesis work. Meaning, Lindab must next develop an approach for where the framework of which now can be provided generates an actual optimal solution for a given supply chain network change. Hence, further research much be done in order to develop a corresponding optimal solution tool to the framework of which this thesis work is

about. Meaning, the framework provides a structure for which parameters are important and should be considered but not an actual optimal solution, though such a tool could be further investigated in the future.

In connection to the relations between different parameters, the challenge of non-quantifiable parameters can be further strengthened with the development of a standardized scale to represent the parameters. Meaning, much like one know from Risk management (of which Lindab is familiar with as well) a scale and matrix to consider the impacts and possibility of a non-quantifiable parameter could contribute with additional knowledge to a discussion on the parameters. Obviously, such a scale must be built on consistency and knowledge to be beneficial. Hence, in-house specialist needs to be located and in case of no such availability, outsourced resources, databases, or systems could be considered helpful on this matter. Furthermore, handling the non-quantifiable parameters would add further rese/arch and development, to not just the future goal of a digital twin, but also to the improvement of the framework in general.

Additionally, it can be argued to be several future research areas which can contribute with improvement of the framework in general. Firstly, this case study involves Lindab as a company, hence only represented by their philosophy and industry when developing the framework. In order to further test and improve, it could be beneficial to do a similar case study for a different company or industry, hence a multiple case study will widen the scope, and the areas of decisions making which the framework can contribute to. Moreover, the developing of the framework was limited to the 16 interviews of which were contributing to the work. Meaning it is possible that involving additionally employees, and employees of functions which are not represented in the interview findings today, could contribute with additional knowledge that could further develop the framework. Though the interview candidates relative to the scope of this case, are considered to be a sufficient amount of interviewees. In connection to developing the framework further with the help of an industry, a possibility is also to dive even deeper into additional research on the topic. Meaning research on additional parameters, interlinks and considerations when doing change projects for supply chain networking. One must though remember that a framework should be presented beneficial for future use, hence avoid a high degree of complexity or amount of parameters which would be unrealistic to work with. In summary, further research on both industries but also from a literature aspect, will continuously improve and further develop the framework. Moreover, having in consideration that the nature of the environment of which is researched is considered dynamic rather than static.

9. Conclusion

In this chapter, the research questions are answered and further recommendations of suggested actions for Lindab are presented.

9.1 Answers to Research Questions

To support the purpose of the study, three research questions were formulated in the beginning of the thesis. In order to conclude on these research questions addressed, both an approach of conceptual literature research and industry specific research was conducted in order to develop a framework for parameters of interest in supply chain networking. This framework was further tested and analyzed relative to two real-life cases. Thereafter, each chapter has been created with the ambition to fulfill the purpose and answer the research questions. Hence, the conclusion of the thesis is summarized by answering the research questions individually below.

RQ1: ***How is Lindab's current supply chain network designed?***
This question is mainly answered in chapter 4.1 presenting a visual flow of Lindab's current supply chain network.

Lindab has a well-established supply chain network in Europe, with their central production located in Grevie, Sweden and Prague, Czech Republic. The process of material always starts at Lindab Steel located in Grevie who provides Group Centrals (GC), Domestic Centrals (DC), and Domestic Locals (DL) with material. External suppliers also provide GCs, DCs, and DLs with products. The network is divided into four sales regions, sales region northern Europe (SRNE), sales region west Europe (SRWE), sales region east Europe (SREE), and sales region mid Europe (SRME). Since GCs, DCs, and DLs could possess several roles, like production, warehousing and distribution, the network becomes complex. Consequently, there are several potential decisions that could be made in relation to how the flow of material should be designed. Through the study, it has been made clear that the flow in the supply chain network is designed based on historical decisions that were especially made relative to low costs.

RQ2: ***What parameters should be included in the framework for decision-making?***
The resulting parameters that are identified to be of importance and therefore included in the framework are based on literature and recent research combined with interview findings. These are summarized in table 14.

Table 14. Final parameters included in the framework

Final Parameters	
Costs	**Investments**
Labor	Cost of investment
Freight	Pay-off time
Material	**Legal & Political**
Overhead	Laws
Inventory	Regulations
Packaging	Wages
Production	**Measuring**
Alternative	Volume
Country	Capacity
Culture	Utilization
Mentality	Fill-rate of transportation mode
Competence levels	**Productivity**
Government	Productiveness of a process
Customer Service	Transportation frequency
Delivery precision	**Products**
Lead-time	Specifications
Quality of products	**Resilience**
Inventory availability	Flexibility
Efficiency	Adaptability
Efficiency of machinery	**Savings**
Environmental Sustainability	Profit
Emissions (CO_2)	Revenue (EBIT)
Energy consumption	Sales
Scrap	**Social Sustainability**
Health & Safety	Employee satisfaction
Incidents per month	Ergonomics
Lost time incident frequency (LTIF)	

RQ3: ***How do different parameters drive the design and redesign of the supply chain at Lindab?***

It has been made clear that cost parameters are the main drivers for designing the supply chain network at Lindab. Historically, decisions in the supply chain network have been made relative to low costs, especially low labor costs. However, parameters like environmental sustainability, has become more prioritized and important at Lindab today. The challenge with "new" parameters is that data is not available and decisions relative to these parameters are made on feelings and assumptions. As acknowledged when testing case 1 and 2 on the framework, there is a high amount of data available relative to several parameters, but this is not used when evaluating decisions at Lindab. It was made clear that parameters in step 1 in the framework (costs, investments, and savings) are more frequently included in the decision-making process rather than parameters in step 2 and 3. Several parameters in step 2 have available data but this is not known among some employees or just assumed to be "good" or "bad". In summary, it

was confirmed through testing that the parameters in step 1 are the main drivers for designing the supply chain network at Lindab.

When looking generally on which parameters that drive the design and redesign of the supply chain at Lindab, it was learned through the work that in majority the parameters deemed quantifiable are the main drivers for design or redesign. Though many parameters showed data availability as described above, the main parameters driving the design or redesign were the parameters of which represented financials (costs, savings etc.), rather than customer service, sustainability, health & safety etc., even though they were just as represented by data availability. Though it can be concluded that the data availability in terms of becoming data driven is deemed to be there, the work showed an indication of a pattern of design and redesigns solutions still highly dependable and decided upon the historical approach of costs rather than several data driven parameters.

9.2 Recommendations

Based on the results and analysis of this project, it is recommended that Lindab continue working with their data availability relative to the different parameters. Having data close to the processes, and consequently the parameters, enables an easier usage of the data. Furthermore, having data close to the processes will not require as much data cleansing before using it. Accordingly, it will facilitate the overall goal to become data driven. Another recommendation relative to becoming data driven, is the way to handle non-quantifiable parameters. One suggestion is to create a scale that non-quantifiable parameters can be applied onto. The scale enables a standardized method of managing non-quantifiable into becoming quantifiable and the possibility to be considered in a data driven purpose.

Another recommendation relative to data gathering, is the way of how data is communicated, collected, and available for different employees at Lindab. There should be a greater transparency regarding data availability and accessibility for employees to facilitate the data gathering process. As a suggestion, a structured way of collecting data should be provided, with the framework seen as a foundation of what data that should be available. Since data could be available on a local and global level in the company, it is also necessary to be consistent with the gathered data.

In general, Lindab should continue working with "The process of using the framework" (figure 21) developed in the thesis, specifically step 3 (*Gather data on parameters*), step 4 (*Is all data available?*), and step 5 (*Analysis*). The next step for Lindab, before moving into a digital twin, should be to develop an optimization tool to easier run through the process of these steps. The tool should be able to turn big data into actionable insights in order to facilitate the analysis of a change project and the corresponding decision.

Beyond the technical recommendations, a cultural recommendation is also suggested relative to change management. As it was learned, decisions are mainly based on cost parameters today, this is a common practice that needs to be changed to further involve other important parameters in decision making. To facilitate this change, it needs to be communicated in the organization, and a structured method of including more parameters than costs should be introduced.

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Appendix

Appendix 1 – Interview Guide

Interview Guide

Interview questions on changes at Lindab

A semi-structured interview, with open-ended questions, with the intention to motivate a discussion on the topic in question.

General introduction to you

What is your job function and what is your responsibilities?

- What are the typical tasks you do?

Can you describe the flow that you are responsible for? (The steps for doing your tasks)
Do you have any visual flowchart(s) of your tasks/processes?
What are the most important KPIs/goals (or similar) for the job you do?

- How do you prioritize among them? (if you do)
- What parameters do you think affect these KPIs/goals?

Changes & parameters

Can you mention some changes that have been made in your division?
Which parameters did you consider doing these changes?

- Did the considered parameters turn out to be relevant for the change(s)?
- Did the change(s) affect other parameters, which and how?
- Would you consider other parameters if you were to redo it?

What are some changes you expect to happen in the future? (both planned and not planned)

- How do you expect future changes to affect different parameters?

In general, when looking at changes from your position,

- Do you think there are parameters which are under or over prioritized?
- Are there parameters which are simply ignored/accepted?

Which parameters do you think are most important to include to represent your function/tasks in a framework?

- Which other divisions affect your changes and parameters and in what way?

Appendix 2 – Definition of parameters

Definition of parameters

Step 1	
Parameter	**Definition**
Costs	
Labor	The sum of all wages paid to all employees or one employee, can consist of variables relative to shifts, overtime etc. Can be further divided into direct and indirect costs.
Freight	The amount, which is paid for transporting goods/ product from one place to another. Meaning, from raw material to customer. Consists of fixed and variable (operating) costs e.g. fuel, distance, insurance, maintenance and transport mode.
Material	The costs of raw material used to produce a product or service.
Overhead	Overhead is expenses that is not linked to a specific product or product line. Refers to the ongoing costs to operate a business (excluding the direct costs) which corresponds with creating a product or service e.g. rent, utilities, insurance, office supply, travel, advertising, tax, energy, indirect labor costs, management costs.
Inventory	The cost for holding, administrating, processing and handling a product, service or stock at facilities as a total sum. Alternatively, the value of which the inventory represents on a given market.
Packaging	The cost of all packaging, coverings and machinery used to secure or transport a product e. g packaging material, pallets, cages, wrapping machines etc.
Production	The costs of all direct and indirect expenses used when producing an item or service. Can be expressed as the total sum of both fixed and variable costs, relative to the number of units produced. E.g. using the fixed and variable costs from labor, inventory, packaging and overhead.
Alternative	The cost and value of a potential alternative compared to another solution. E.g. the difference in return between making an investment and not making it.
Investments	
Cost(s) of investment	The costs needed for an investment including both upfront costs and cost of benefitting from the investments underlying assets. E.g. education, automation, robotics, digitalization, capabilities/ resources, technology, companies.
Pay-off time	Expressed as an investment plan with corresponding ROI, breakeven point or payoff time, hence individually evaluated for each investment.
Savings	
Profit	A financial gain expressed in money or assets, specifically the difference between the amount earned (revenue) and the amount spent (costs).

Revenue (EBIT)	The total amount of money earned from selling products or services to customers or other parties. Typically expressed with EBIT (earnings before interest and taxes).
Sales	The amount of total transactions from customers where customers receives products, services or assets. Can be expressed simplified with Total Quantity sold.
Step 2	
Parameter	**Definition**
Products	
Specifications	The product specifications include information like dimensions, length, type, volume, weight, and square meters.
Customer Service	
Delivery precision	The percentage of on-time deliveries (a delivery that is delivered on the promised date). Possibly further distinguished between internal and external (customer) delivery precision. Could be expressed as the number of on-time deliveries relative to the number of total deliveries.
Lead-time	The time between a sales order and arrival to customer.
Quality of products	Return rate of products (defect products) in comparison with the total delivery of products.
Inventory availability	The available inventory in stock in real time to meet customer demand.
Measuring	
Volume	The volume of products moved in the supply chain. Divided in three segments of transported volume (logistics), produced volume (manufacturing) and handled volume (warehouse)
Capacity	The max capacity you are able to take on considered in both production (machinery) and warehouse facilities.
Utilization	Used capacity relative to the available capacity for production and resources (machines, shifts etc.)
Fill-rate of transportation mode	Used volume relative to the available volume in a transport mode.
Efficiency	
Efficiency of machinery	Overall equipment efficiency (OEE) including schedule loss, availability (unplanned and planned stops), performance (slow cycles and small stops), and quality (defects and rework)
Productivity	
Productiveness of a process	A measurement that tells you the productivity of a given process. In example, transactions per employee or pieces per man-hour. Hence, an expression of the productivity relative to the process of question.
Transportation frequency	The number of vehicles, which goes on a specific route per time unit (week, day month etc.)

Environmental Sustainability	
Emissions (CO_2)	The emissions caused by transport (distance, mode, truck type, volume and weight), production (machinery), and the production of steel (fossil fuels)
Energy consumption	The energy/power consumption required to run the business (production and facilities), e.g. electricity, heating, water, gas.
Scrap	The amount of leftover material due to production of products.
Step 3	
Parameter	**Definition**
Country	
Culture	Considerations regarding industry understandings, mindsets, behavior, language, bureaucracy, safety etc. in relation to a certain country.
Mentality	Different mindsets like individualism, team player, realistic/non-realistic, how goals are approached etc. in relation to a certain country.
Competence levels	Considerations regarding competence level(s) in the country and do the employees have the right competence to fulfill the tasks needed for the job.
Government	Considerations regarding the governmental influence on business and the political situation in a certain country.
Legal & Political	
Laws & Regulations	Reflection regarding current laws and regulations that could affect or challenge the project, for example, Brexit.
Wages	Reflection on possible regulations on wages that could challenge the project, for example changes in minimum wages, contract benefits etc.
Resilience	
Flexibility	Flexibility of moving capacity and resources in the supply chain to meet future demand, challenges and avoidance of redundancy. Hence, flexibility to run a robust supply chain in a non-static environment.
Adaptability	Being able to adapt to a new location and set-up in terms of resources and competence.
Social Sustainability	
Employee satisfaction	Considerations on employee's satisfaction levels at a workplace, In example the ability to keep learning and developing within a position, and possible consequences of replacing manual work with automated solutions.

Health & Safety	
Incidents per month	Monitoring of incidents per month connected to a location, specific production lines or facilities. The number of incidents considered relative to the impact and probability of a risk driven from a risk assessment (risk matrix).
Lost time incident frequency (LTIF)	A measuring of the time lost due to injuries, typically measured pr.one million worked hours.
Ergonomics	The considerations regarding ergonomics in the segments of physical (anatomical), cognitive (mental processing) and organizational (structures and policies)
Location	
Costs	The parameter “location” is used to evaluate and compare different locations in relation to the total costs, the total emissions, and the average performance on customer service parameters.
Emissions	
Customer service	