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Development of a Tactical Strategy for a Supply Chain Control Tower

Master's thesis in Supply Chain Management

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Summary

Complexity in supply chains (SC) has increased together with companies strive for globalization. The competitive environment has led to the increased importance to manage this complexity in order to ensure the efficiency of the SC. Today, digitalization is picking up speed globally and companies have understood that this is a tool to improve their own SC competitiveness. There are several different ways to create SC digitalization efforts, where Volvo Group has decided to initiate a project to digitalize their inbound SC to increase its competitiveness.

Volvo Group has decided to create a SC Control Tower (SCCT) to improve the digital competitiveness in its inbound SC. A SCCT is in short about increasing the digital visibility of a company's SC. In this master thesis, the aim is to design a tactical strategy (design a strategy and short-term tactical steps that fulfill the strategy) for Volvo Group's SCCT. To understand how to design the tactical strategy for Volvo Group's context there is a need to understand the complexity challenges Volvo Group are facing in their inbound SC. The objective of the tactical strategy is to support the management of complexity and to maximize the business outcome for Volvo Group.

The master thesis builds on different sources of data, including interviews at Volvo Group, academic literature, and external sources (e.g. consultancy reports). The interviews were used to achieve a deeper understanding of Volvo Group's inbound SC and their complexity challenges. Also, they provided a reference point regarding limitations and possibilities for a SCCT in the Volvo Group context. A SCCT is a rather unexplored area in academia and therefore, an analytical framework of how to develop a tactical strategy for a SCCT was created and used.

The tactical strategy that was developed consists of a SCCT-strategy and three tactical steps prioritized to fulfil the strategy with the highest possible business outcome. The strategy consists of nine features deemed to be feasible to achieve within three years, each feature contributes to the improvement of the management of SC complexity and performance. The finalized tactical strategy breaks down and prioritizes the nine features into three tactical steps referred to as the (1) digitization-, (2) digitalization- and (3) decision-support step.

The thesis ends with conclusions regarding the implementation of the SCCT strategy at Volvo Group. The success of the SCCT is not only dependent on the tactical strategy itself. A successful implementation will require Volvo Group to work with change management and how Volvo Group work with the actors in their network

Keywords: Supply Chain Control Tower, Supply Chain Complexity, Supply Chain Networks

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List of Abbreviations

B2B	Business-to-business
B2C	Business-to-customer
ETA	Estimated Time of Arrival
FTL	Full Truckload
IS	Information Systems
IT	Information Technology
LTL	Less than full truckload
MTO	Make-to-order
OIC	One information chain
OEM	Original Equipment Manufacturer
SCCT	Supply Chain Control Tower
SCOR	Supply Chain Operations Reference Model
SC	Supply Chain
SCM	Supply Chain Management
Volvo GTO	Volvo Group Trucks Operation

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1 Introduction

In this section an introduction to the subject and the research questions this master thesis intends to answer are presented.

1.1 Background

Historically, companies have been seen as separate entities competing for their success. The historical mindset was that a supply chain (SC) was not seen as an integrated part of a business, thereby not responsible for a company's success (Lambert & Cooper, 2000). However, this individual mindset has changed. The focus has changed from companies being responsible for their success towards a view where the whole SC together influences how well they can fulfill customer demands. The result is that companies no longer compete individually, instead there is a view developed where a SC competes with other SC's. Ivanov et al (2017) clarify that members of a SC can achieve synergies by collaboration and thereby increase the business outcome for the whole SC. The result when exploiting synergies creates additional value to the consumer and therefore the SC becomes a part of the company's competitive advantage (Fawcett & Magnan, 2001). For this reason, supply chain management (SCM) has become of utter importance for companies, as it helps to control and develop SC capabilities (Chopra et al, 2013).

To find synergies throughout the SC to increase efficiency is not easy due to the complex nature of SC's. Mentzer et al (2001) explain that understanding how SC members influence each other is often too complex for the human mind to process. To handle complexity and to achieve an increased SC performance, technology is often used to manage the SC. The use of technology in SC performance improvement is nothing new. Mentzer et al (2001) explain computer simulations were used already in the 1950s to simulate how the well-known bullwhip effect (increased inventory swings as a result of shifting customer demand) could impact a company's SC and its members. Digitization, the conversion from analog information into digital (Bloomberg, 2018), in SC's has historically been present and helped to increase SC performance. This results in that technology has been and will continue to be an important part for SC's to further improve (Chopra et al, 2013).

What is new today, is the speed of technological advancements, where digitized data and technologies are used to change the way companies do business. Digitalization transform the way organizations interact, or operate in better ways through technology (Bloomberg, 2018). Commonly known as digitalization, which has revolutionized companies SC capabilities. In a consumer-centered perspective, Büyüközkan & Göcer (2018) describes how the global way of life has changed by digitalization and helped simplify our everyday life. Everyday activities such as shopping are done in completely new ways. E.g., PostNord (2019) discovered during June 2017, 36% of the Nordic people did shop online from their smartphones. In June 2019, the same number was increased to 49%, which indicates how digitalization changes the way individuals do purchase.

Taking a business perspective of the development, Pagani & Pardo (2017) discusses that the speed of digitalization in business-to-consumer (B2C) and business-to-business (B2B) markets vary. The authors explain B2C markets have been more rapid in the adaptation of technological advancements downstream in their SC's. One recent B2C example is P&G, digitalized their SC to ensure product availability to consumers (Cosgrove, 2019). P&G is collecting real-time data throughout its SC and its surrounding environment. This data is combined with analytical tools to analyze future events and disruptions. In 2017, during Hurricane Harvey in Texas, the system generated alerts by using SC- and weather-data to predict how the disruptions would affect SC activities days before the storm. This facilitated P&G's resource re-location and rearrangement of SC activities, helping P&G to avoid the hurricane without any major disruptions. By digitalizing their supply chain, P&G was able to quickly visualize the magnitude of the disruption and analyze alternative options to find a solution that would minimize negative outcomes.

Pagani & Pardo (2017) highlights that the digitalization adaption in B2B-networks is also changing, however, at a slower pace and are therefore lagging compared to businesses closer to end-consumers. However, there are reasons to believe that the digitalization efforts of B2B companies will increase drastically. The P&G example by Cosgrove (2019) shows that disruptive technology already exists today. B2B companies could generate a competitive advantage by improving the SC operations through the digitalization of their SC with already existing technology and competence. The importance of competitive SC operations has been shown repeatedly in the history. A historical example and to highlight the importance of having a competitive SC, is provided by McInter (2014): *"HP is losing market share against Dell due to consistently holding more inventories when a technology component (like a processor) became obsolete".* In this case by Mcinter (2016), HP was not able to match Dell's SC performance which affected the business outcome, resulting in lost market shares. In the current B2B market where digital capabilities are developing, similar events can occur when businesses gain competitive advantages through their SC digitalization efforts (Büyüközkan & Göcer, 2018).

Volvo Group is an original equipment manufacturer (OEM) that produces trucks, buses, construction equipment, and industrial drive systems. As previously stated, SC digitalization is becoming increasingly important for companies operating in a B2B-market. Volvo Group is no exception and needs to adapt and improve their SC digitalization efforts to stay competitive. This master thesis is done on behalf of Volvo Group Truck Operations (GTO), which manages all truck operations in Volvo Group. They have a highly complex SC which consists of a large number of suppliers, who perform a wide range of activities. The activities have a dynamic nature where deviations can emerge, which further increases the complexity when the deviations need to be handled. Furthermore, most of Volvo's suppliers are present in multiple SC's, such non-linearity increases the complexity as more networks need to be considered. By managing the complex nature of Volvo Group's SC, better performance can be achieved, which highlights why digitalization efforts are of great interest.

Volvo Group has started to roll out a SC IT project which aims to centralize the information flow within their SC and to convert the analog information flows to digital flows. The SC-digitization initiative has enabled a sub-project, the development of a "Supply Chain Control Tower" (SCCT). This master thesis will focus on the development of the SCCT at Volvo Group. A SCCT is defined as "*... a process of collecting supply chain data, integrating it, extracting intelligence from it, and using that intelligence to interrupt decisions in a cross-organizational supply chain-oriented context" (*McInter, 2014). Successful implementation of a SCCT would support the management of the complex nature of Volvo Group's SC and increase its performance.

1.2 Purpose

The purpose of this master thesis is to develop a tactical strategy for the Supply Chain Control Tower project for Volvo Group. The tactical strategy consists of a strategy where the SCCT shall be in three years and tactical steps needed to be executed to fulfill the strategy. The objective is to formulate a tactical strategy that supports the management of SC complexity and strives to maximize the business outcome.

1.3 Problem Discussion

Globalization and a competitive business environment have increased SC-complexity (Isik, 2011). This has inevitably created a higher pressure on the importance to handle complexity challenges to stay competitive. Isik (2011) continues that an inability to handle the complexity will result in negative consequences e.g. an increase of operative costs, lead times, and integration difficulties with suppliers and customers. By reducing SC complexity, companies can thus achieve positive impacts such as SC-efficiency and -effectiveness improvements (Isik, 2011), which in turn can result in an increased competitive advantage. Volvo Group has experienced a high level of SC-complexity during the last couple of years. Therefore, it has become an important topic for Volvo Group to solve the SC-complexity challenges.

A SCCT could potentially reduce SC-complexity through SC transparency, provide insights of required actions, and provide decision support. Successful implementation of a SCCT may help reduce Volvo Group's SC-complexity. The development of a SCCT is an incremental process where new abilities and features can be added over time. To achieve the success of a SCCT implementation a strategy and targeted objective is needed for Volvo Group. This master thesis is focused on a three-year time span, where the strategy will be designed after that given criterion. Furthermore, the strategy will need to be broken down into manageable tactical steps. Where each step shall be designed to maximize the short-term business outcome.

1.4 Research Questions

The first research question aims to understand what the key complexity challenges are within the inbound SC of Volvo Group. Thereby, provide a foundation of what the key areas are of improvement.

> **RQ1:** *What are the current key challenges related to supply chain complexity for Volvo Group's inbound SC?*

With the key complexity challenges as a foundation from RQ1, areas with large business value are identified. The complexity challenges combined with interviews, literature, and external sources are used to design the tactical strategy for Volvo Group's SCCT, which is the aim of the second research question.

> **RQ2**: *How can a tactical strategy be designed for a Supply Chain Control Tower to maximize the business outcome?*

1.5 Delimitations

This master thesis is limited to Volvo Group's suppliers connected to their truck operations, named Volvo Group Truck Operations (GTO). Therefore, all references to Volvo Group in this master thesis refers to Volvo GTO. The decision was done to simplify the complex organizational structure of Volvo Group.

The master thesis observed the inbound SC of Volvo Group. The inbound SC is set between the highest tier suppliers to the arrival at Volvo Group's production facilities. Volvo Group's inbound SC consists of a massive number of actors and activities. To analyze and create a master thesis of the whole inbound SC, the master thesis took a top-level approach. It resulted in that all technical aspects could not be included. The master thesis limits itself to the primary physical flow of Volvo Group further described in section 5.1.2.

1.6 Structure of the master thesis

In this section the structure of the master thesis is presented.

2. Method	Explains the method used and how the master thesis collects & analyses data.
3. Literature Background	Provides a theoretical background to the supply chain context and related concepts used throughout this master thesis.
4. Analytical Framework	In this chapter, an analytical framework is created for developing a tactical strategy. The Analytical Framework is divided into two parts. The creation of a SCCT-strategy and the creation of a SCCT-tactical strategy.
5. Description of Volvo Group’s inbound Supply Chain	Provides the reader with an understanding about the empirical context about Volvo Group’s inbound SC and the complexity challenges they are experiencing. It provides a foundation for the SCCT.
6. Analysis of Volvo Group’s inbound Supply Chain	In this chapter the analysis is conducted of Volvo Group inbound SC. The analysis includes for instance why Volvo Group has today chosen to structure their inbound SC in this way.
7. Strategy for Volvo Group’s SCCT	In this chapter we use the first part of the analytical framework on Volvo Group. The creation of the strategy uses a market analysis in combination with company-specific knowledge to create a feasible SCCT-strategy. The part requires an understanding of Volvo Group’s current inbound SC.
8. Tactical Strategy for Volvo Group’s SCCT	In this chapter we apply the second part of the analytical framework. The analysis uses the SCCT-strategy to create a prioritization and tactical steps on how to achieve the strategy. Thereby, formulate the tactical strategy.
9. Discussion & Reflection	This chapter discusses the SCCT in consideration to theory and company-specific information. The section touches on “softer” factors than previously discussed through the analytical framework.
10. Conclusion	The final remarks from the master thesis.

2. Method

In this section, the design and methodology for how this master thesis collects and analyses data is presented.

2.1 Research Design

Bryman & Bell (2015) explain that business research is quite difficult and requires a certain number of procedures are executed correctly. The authors continue that an exploration of current literature concerning the topic is often performed to give the researchers a better understanding of the chosen field. Bryman & Bell (2015) continues that humans are not machines and are prone to make mistakes. A research business method should, therefore, work as a protection for the researchers against potential mistakes. It should also help the researchers maintain a structure throughout the study and reduce their own personal bias when it comes to business analysis.

Bryman & Bellman (2015) divides research design into two steps:

The first step in the research design is to separate a qualitative and quantitative research approach. A quantitative research approach is often based on empirical investigations analyzing a large quantity of data, suitable in the testing of theories or hypothesis. Qualitative research is often appropriate when testing new theories or practices. Data collection often stem from interviews and observations. Bradley et al (2007) continue that qualitative research often focuses on discovering previous unknown links between concepts and theory. However, the authors also argue that it is okay to sometimes mix the different approaches and add a quantitative part in the qualitative study if it can help answer the research question. This master thesis investigated a topic previously not well-studied with limited academic literature available. Therefore, a qualitative research strategy was chosen to gain insights from interviews and observations in the industry.

The second step according to Bryman & Bellman (2015) is to decide how to reason when conducting the study. There are three types of reasoning, deductive, inductive, and abductive. Deductive reasoning is derived from the creation of a hypothesis based on theory and observations, it builds a hypothesis that is tested to be either confirmed or rejected. Inductive reasoning is based on the observation of the problem, to later generate a theory based upon that specific observation, the creation of theory. Abductive reasoning is similar to inductive reasoning with a more pragmatic approach. Abductive reasoning aims to observe the problem and then generate the most probable cause of explanation, the creation of a plausible outcome. Abductive is often preferred when a theory cannot fully cover the subject (Dubois & Gadde, 2002). This study was structured based on abductive reasoning because of the need to create new unexplored findings and adapt it to Volvo Group’s business environment.

The next step after the research design is to develop the strategy of how the data should be collected and analyzed.

2.1.1 Case Study

Bryman & Bell (2015) states that a case study research strategy can be an appropriate strategy if the goal is to get a more exhaustive and holistic view of the problem that the research intends to study. A case study often uses the analysis approach that is called triangulation (Denzin, 2009). Where triangulation strength comes from the collection from different data methods and different analysis tools. Therefore, creating higher quality research if the subject has not previously been examined. A case study intends to examine something from a real-life perspective where multiple interviews, observations are combined with theory to get an increased richness and depth about the problem. Bryman & Bell (2015) argues that a case study should also be used as an iterative process method where the researchers constantly gain new information about the subject. The newly gained information can be used to create new connections within the case study.

A SCCT is not a well-studied field in academia and supply chain management. Therefore, a case study research approach is appropriate to get data and knowledge from different data sources. The main data sources are in the form of interviews, academic literature, and external data, e.g. consultant reports. Therefore, the use of triangulation in regards to the problem is used to get a deeper understanding of the complexity challenges that Volvo Group faces and how they can be solved using a SCCT.

To achieve the tactical strategy the master thesis used a broad scope of the inbound supply chain from the beginning to understand the challenges and foundation. The tactical strategy only addresses a small portion of the total inbound supply chain. However, the master thesis has an aim for three years, therefore the tactical strategy was created to be achievable and reasonable.

2.2 Data Collection

The data was collected by three different methods from interviews, academic literature, and external sources.

2.2.1 Interview Structure

There exist three different interview types, structured, semi-structured, or unstructured. Each interview type has its strengths and weaknesses depending on what the interviewer wants to gain from the specific interview. In this master thesis, the interviews aimed to gain a deeper knowledge about Volvo Group’s inbound SC and the SCCT-project. Hence, the interviews are semi-structured, and all interviews followed the same structure. A semi-structured interview lets the interviewee further explain subjects that might have been overlooked or missed in preparation. According to Campion et al (1997), the structure of the interview-questions is of utter importance to maximize the value created in each interview. The interview structure can be seen in appendix II.

2.2.2 Academic Literature

The theoretical framework provides the reader with a theoretical background about what the literature states are common themes within the integration and development of SCM. The literature is collected from Google Scholar, Scopus and Chalmers Library using the search words "Supply Chain Control Tower”, “Operational Control Tower”, “Supply Chain Digitalization/Digitization”, “Supply Chain Networks”, “Supply Chain”, “Business-To-Business market networks”, “Supply Chain and IT”, “IT and Change Management”, “Supply Chain Visibility”, “Supply Chain Traceability”.

2.2.3 External Sources

Three consultant reports were used to describe a SCCT from an alternative best-case point of view. The aim was to provide the reader with an alternative view about a SCCT compared to the academic literature. The consultant reports describe a picture of what a fully developed SCCT is from a business perspective. The reports were used to understand a reasonable objective for Volvo Group's SCCT.

2.2.4 Conducted Interviews

Interview preparations were done beforehand each interview, and the interview forms can be found appendix II. The interview forms were created to answer the research questions. The goal was to create an understanding of the complexity challenges at Volvo Group and to get an understanding about the Supply Chain Control Tower-project at Volvo Group. Therefore, there exists two different interview forms in appendix II. The interview followed the same structure to make them easier to compare qualitatively. However, because the interviews were semi-structured they could sometimes deviate from the interview form. Certain interview objects had more information about specific areas of the inbound SC. Therefore, the focus on their interview could be on the expertise in that specific area.

The interview object was selected first based on our tutors at Volvo Group. The selection was based on the interview objects experience of Volvo Group's inbound SC. Each interview objects also gave recommendations to other employees deemed a good fit for the master thesis. A quote from one interview object "you guys pretty much covers the dream-team of Volvo Group's inbound SC". The quote gave validity to that the interview objects were correctly chosen and had a high knowledge of Volvo Group's inbound SC. The interview objects can be found in table 1.

To achieve validity in this master thesis the context for each interview is described, how the interview object was contacted and that all interviews were recorded and transcribed. The interviews were also re-read and coded.

The first conducted interviews painted a picture of the complexity challenge. Therefore, the later interviews could focus more on going in-depth about the different challenges and how they could be related to the SCCT. The last interview with the "VP Material Supply" was used to validate the complexity challenges that had been observed. The interview together created an understanding about how everything connects.

Table 1 - List of the title of interview object and date of interview

Title	Date
Business Sub Portfolio Manager	11/2/2020
Acting Delivery Manager	13/2/2020
Director Transport Packaging Management	18/2/2020
Strategy Development Manager	24/2/2020
Director Transport Optimization	25/2/2020
Project Manager Material Transport	25/2/2020
Manager Express & LSS Gothenburg	25/2/2020
Business Process Developer	26/2/2020

VP Digitalization & IT	26/2/2020
Director Supplier & Material Management	26/2/2020
VP End to End Production Logistics	27/2/2020
Director Logistics Purchasing EMEA North	28/2/2020
Program Prep & One Info Chain Manager	28/2/2020
VP TO EMEA	27/2/2020
Business Process Manager	3/3/2020
SC IT Architecte	6/3/2020
VP Material Supply	12/3/2020

2.3 Data Analysis

In this section, two parts are presented. The first part describes how the collected data from the interviews were analyzed and compared to the research questions. The second part describes how an analytical framework was created to answer the second research question.

2.3.1 Analysis of the collected data

Bradley et al (2007) state that there are several different approaches to how researchers can choose to analyze qualitative data. The authors continue that the only general agreement between researchers is that an iterative approach is of importance in consideration of qualitative research. An iterative approach is described as a certain number of tasks carried out in the same sequence multiple times. To ensure that information is not lost in translation. Leech & Onwuegbuzie (2008) mentions that there are several different data analysis methods, the authors state it is okay to modify the method for how the analysis is created independence on what the researcher's aims to investigate.

In this master thesis, a modified version of the QUAGOL framework by Casterlé et al (2012) has been used. As previously mentioned, the main source of data is collected from interviews connected to Volvo Group's inbound SC. The first step after each interview was to transcribe the interview, write notes about the interview object and re-read the transcribed interview, to ensure each interview was carried out in the same fashion. It allows the researchers to understand the data compared to the intended research questions.

The second step was to create a narrative for each interview. "Key storylines of the interview" to highlight what was the most important findings of each interview.

The third step was to create a conceptual interview scheme, where each code of information was valued compared to the other interviews. The goal was to get a deeper insight into what each interview provided and how the knowledge from each interview was connected.

The fourth step was to constantly move back and forth between the different interviews. The fourth step was created to help maintain the "older" interviews to be relevant and that crucial information was not lost. The process is described in figure 1.

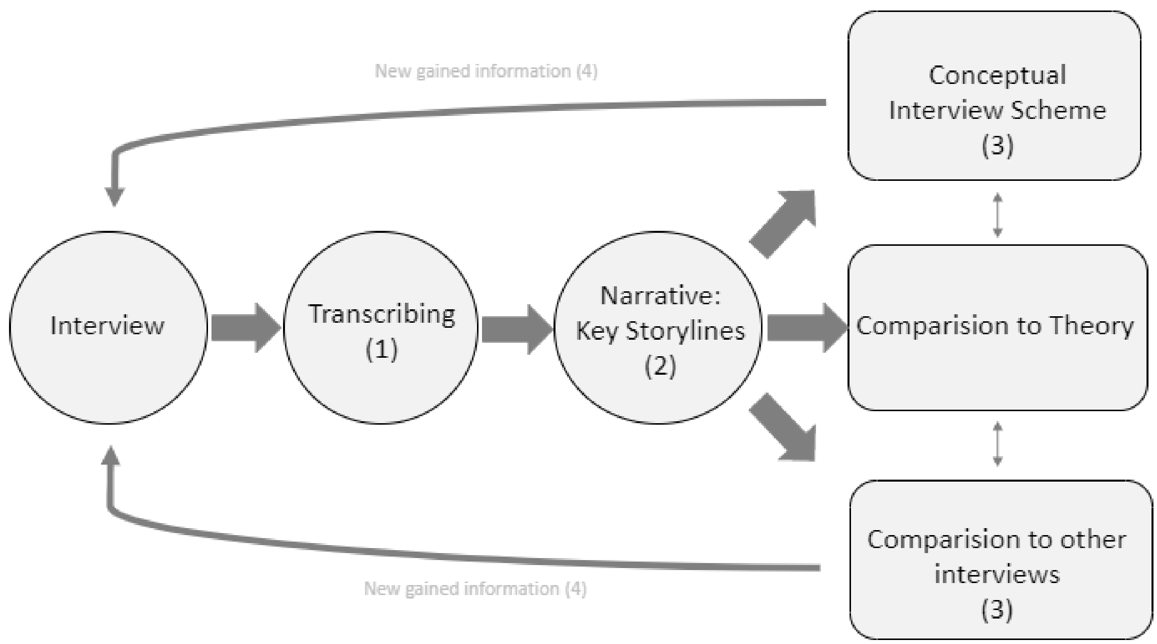

Figure 1 - Structure of the analysis process, based on the QUAGOL framework by Casterlé et al (2012).

De Casterlé et al (2012) explains a second part for how to analyze qualitative interviews, the steps require software that can create codes of information. In this study, no software was used and the clustering and coding were done by hand. After the first part of de Casterlé et al (2012) framework, the information was clustered and mapped compared to Volvo Group's inbound SC. It generated the challenges in the inbound SC.

2.3.2 The creation of an analytical framework

To answer the second research question there was a need to develop an analytical framework presented in section 4. The analytical framework was structured to explain and break-down the term SCCT-tactical strategy. The framework was created to be used analytically generalizable to companies in similar industrial contexts as Volvo Group. However, the analytical framework is tailored to fit the exact information needed to fulfil the specific research purpose.

The analytical framework breaks down tactical strategy into two parts. The first part describes the process of how a company creates their SCCT strategy. The second part describes how to create tactical steps to achieve the given SCCT strategy, together forming the SCCT tactical strategy. The analytical framework itself is created with the use of theory and reasoning. However, the usage of the analytical framework requires external data, company specific information and theory. The analytical framework is further described in section 4.

2.4 Research Quality

Collingridge & Gantt (2008) describes that there has been a growing increment of qualitative research during the last couple of years. However, according to the authors how to measure the quality of the qualitative research reports is lagging. Qualitative research is based on reliability and validity just as quantitative research, however, necessarily not adapted in the same way. The authors state that each qualitative research approach has its own merits on how it should be measured. Therefore, each framework needs to be adapted and formed after the specific research questions.

Reliability comes from the word replication and is a key aspect of quantitative studies. Collingridge & Gantt (2008) states its facilities' scientific importance from the understanding of the natural world. To replicate makes it possible for other researchers to test the research quality and therefore strengthen or weaken the hypothesis. According to the authors the same should be stated when it comes to qualitative studies. Where each step of the study should be documented, and the exact terms stated. The methods should be free of bias and provide the reader with a correct picture of how the research was conducted. Therefore, the authors state that reliability in qualitative research is often to use research methods accepted by the research society. Collingridge & Gantt (2008) continue in qualitative research it is not about achieving the same research result every time but "…achieving consistent similarity in the quality of the results".

To achieve reliability in this master thesis all the steps conducted were described, the same pattern was used for each interview as well as the same background information. Qualitative research has an impact on the analytical abilities of the interviewee and transcriber according to Collingridge & Gantt (2008).

Validity means that the research measures what the study intended to measure. Collingridge & Gantt (2008) states that validity in qualitative research is based on how to choose an appropriate method to answer the research question that the study intends to answer. The authors continue the method that must be used "coherently, justifiable and in a rigorous manner". Collingridge & Gantt (2008) states three main features for validity in qualitative research, first to describe the surrounding of the specific research situation, e.g. the intangible situation, context, etc. Secondly, to use proper interview- and observation- techniques and thirdly, to collect results that can be measured and compared with other research studies related to the same topic.

2.4.1 External Factor: Covid-19

During the winter 2019/2020, the SARS-CoV-2 virus (commonly known as Covid-19 or Corona) broke out worldwide. It created heavy ripple effects across several industries including Volvo Group. Volvo Group faced a short-term lay off between the 24th of Mars 2020 and the 4th of May 2020 in Sweden. Therefore, the data collection in this master thesis was drastically discontinued on the 20th of Mars 2020. Over fifteen different interviews had already been collected and the results were based on the conducted interviews. However, the master thesis was not able to collect additional data to confirm or re-evaluate certain statements made by the interview objects. Therefore, in certain areas assumptions had to be made.

2.5 Ethics

Wallace & Sheldon (2015) explains that ethics in business research is an important part of the study to be able to receive a trustworthy outcome. The authors continue that business research is built on four main pillars. *"Research merit and integrity"*, which means that all the information is gathered from trusted and accounted sources. In this master thesis, all valid information was collected from academic literature, primary data from Volvo Group, and trusted external sources. *"Justice"*, the selection of interview objects should not be excluded or limited based on research outcome. In this master thesis interview objects were selected based on knowledge about Volvo Group's inbound SC. *"Beneficence"*, the benefits of the study must outweigh the risks and damages it can create. The study was conducted under normal office conditions and was anonymous. *"Respect"*, research should value the individuals under investigation and take into consideration the different ethnical backgrounds, religions, and believes. This master thesis treated everyone equally and uses the same neutral interview procedure to not create confusion for the interview objects.

Before the master thesis, a contract was signed between the researchers and Volvo Group to ensure certain confidential information would not be shared.

3 Literature Background

In this section, the literature background is presented and explained. The section provides the theory about several concepts needed to understand the context of a complex inbound SC.

3.1 Supply Chain Management

In this section theory related to Supply Chain Management and Supply Chain structure is described and presented.

3.1.1 Definition of Supply Chain Management

Mentzer et al (2001) explain that there are several similar definitions for Supply Chain Management (SCM) where the content for each definition is quite similar. The authors state that SCM is the study and practice of the five flows (information, material, money, manpower, and capital equipment) between entities and actors in a SC. Cooper et al (1997) define SCM as "... an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user.". Lambery & Cooper (2000) continues to explain that companies have previously been competing as individual entities, but in today's business environment has become increasingly more competitive which has made companies realized that the success of the individual company depends on all the entities in the SC. The authors continue that this has led to a developed view where SC's compete against SCs. Thereby, the total potential of one company is considered to depend on how well the company maintains and develops synergies with its suppliers and customers. SCM refers to the ability to manage the relationships within the SC and to integrate and manage this SC to achieve additional value (Lambery & Cooper, 2000).

Fawcett & Magnan (2001) continue that with a good SCM-department the company can focus on what they are exceptionally good at. By finding actors who perform activities such as logistics, production, distribution etc. as their core competence. The focal company does not have to waste resources on doing activities that are not within their core competence and instead let other actors in the SC perform those activities for them. Chopra et al (2013) continue to explain that a critical function for the SCM department is aligning the goal of the SC with the business strategy of the focal company. The authors stress that if the SC strategy does not align with the business strategy the company will have a hard time competing with its competitors.

3.1.2 Supply Chain Structure

A SC is defined by a set of three or more entities that are connected to serve a customer's demand. Mentzer et al (2001) continue that the SC is characterized by an upstream- (supplier) and downstream-flow (customer). The authors explain that SC's can look vastly different between companies. The SC consist of various actor collaborating to fulfill the end-consumer demand. Figure 2 describes the channel relationships of a SC. In the top part of the figure, the direct SC contacts of an organization are described as an organization that has contact with suppliers (delivering raw-material or semi-finished goods) and a customer. However, in the middle section of figure 2 an extended SC describes how each supplier has its own suppliers and each customer has its own customers. The structure can extend and create a greater length of the SC. Lastly, in the bottom part of figure 2 it is illustrated how intermediaries (supporting relationships, e.g. transportation and storage between actors) are also actors participating in the SC.

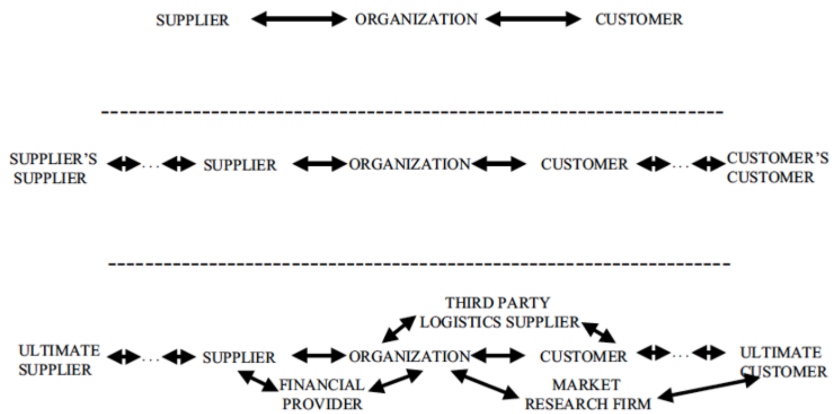

Figure 2 - Examples of supply chain structures (Mentzer et al, 2001)

Stock et al (2000) clarify that even if companies are similar, they often have completely different SC structures. The author explains that two main features are influencing how a SC is being structured. Firstly, geographical distribution and the position of the customer. Secondly, the channel governance that exists within the SC, which is network, hierarchy, or market perspective.

Geographical distribution

This refers to where the focal company's SC is geographically placed in relation to the supplier's position, the production facilities, distributors, or the customer base. The authors continue that the geographic location has an impact on the SC because of three reasons; it influences how different activities should be set up for the focal company, decision making, and coordination is heavily affected by the concentration of geographical distribution and finally, the actual time and cost for physical movement increases with the increase of distance between different entities in the SC (Stock et al, 2000).

Channel Governance

The structure of the SC can vary in the form of control and governance. Where each SC is either managed by a network, hierarchy, or market. In a network, it exists strong links between the different entities in the SC (further explained in section 3.2). In a hierarchy the control is exerted from one player in the network and the market is where the connection and link between entities are low and each one collaborates only for themselves (Stock et al, 2000).

3.1.3 Push/Pull View of Supply Chain Processes

All processes in a SC can be described to be either initiated by a push or pull process. With a push driven process, the execution is initiated in anticipation and on speculation (often forecast-created). For a pull process, the execution of the process is initiated by an order from a downstream member of the SC (Chopra et al, 2013). Push processes operate with a higher degree of uncertainty and have traditionally been used to lower the cost of production through an increase in batch size. While pull processes are initiated by an order (information). This puts higher pressure on that the whole SC runs more smoothly (because of lower levels of inventory) (Chopra et al, 2013). The authors continue that it becomes a question to value the cost of inventory towards production capacity and certainty. Different products need different types of SC-structures because of different degrees of uncertainty. A classic example is provided by Fisher (1997) where the author explains Campbell soup's demand to be constant and therefore the SC can be designed for high efficiency instead of flexibility. This leads to two different production strategies, firstly, make-to-stock (MTS) is when the company produces through a push initiative, forecasting the demand. The SC is often very efficient and the variation in demand stable. Secondly, make-to-order (MTO) is when the production is initiated by a pull signal. The SC is often more flexible where customer demand varies as well as the number of products the production facility can produce (Chopra et al, 2013).

3.2 Further Development of Supply Chain Structures: Supply Networks

In this section theory about the further development of Supply Chain Structures and the development of networks is described and explained.

3.2.1 Supply Chain Networks

The performance of a SC is based on a collective competitive aspect where all SC entities work towards the development of the total SC (Fawcett & Magnan, 2001). This has not always been the case, Rosenbloom (1995) argues that previously the SC's focal company was seen to be the manufacturer, and the SC was typically controlled by that specific actor. The focal company often tried to integrate themselves vertically in the SC and take control over activities upstream and downstream in the channel (Rosenbloom, 1995). Rosenbloom (1995) argues that the manufacturing companies wanted to control the chain to make sure that the perceived image of their product was protected. This was important because companies primarily competed with the physical product. The author continues that the focal company often wanted to limit the opportunistic behavior by channel members and make sure that they could not exploit their position. The channel was not built on trust and commitment but strictly by a hierarchical structure around the focal company as previously mentioned in section 3.1. There was a turning point where companies no longer compete based on the product itself but the total perceived experience for the product (Fawcett & Magnan, 2001). This requires an increased emphasis on working together with the SC network since all activities connected to the product contribute to the total perceived product experience. Ketchen & Hult (2007) argues that an individual firm could never be stronger than the total SC it belongs to. Both Fawcett & Magnan (2001) and Ketchen & Hult (2007) highlight that today there is great importance for companies to focus on their core strength and the couple themselves to a SC that shares the same business objective. Such a SC network consists of specialists focusing on their core competence and it generates an ability to reduce sub optimizing within the network since multiple companies do not perform the same tasks.

3.2.2 Industrial Network Approach

As stated above there has been a change in how companies view their SC according to Gadde (2004), which has changed the view of SC relationships. Today the SC should be viewed as a network. This view is based on the industrial network approach presented by Ford et al (2002). Highlighting the importance to collaborate further, build trust and sustainable relationships between each other. When applying the network approach, a need for different actors to better *coordinate activities* and *combines resources* between each other emerge:

> *Activity coordination* implies a shift from speculation (push) in production to postponement (pull), which means that the item is created through a demand-signal (Gadde, 2004). Moving from mass production and large inventories to stream-lined SC's where processes are triggered through a pull-

signal. Information technology (IT) and integration between the different firms in the SC leads to that speculation is no longer needed between production and consumption. Reducing the discrepancies that Rosenbloom (1995) explains through collaboration and creating a network where all firms exist through interdependency Ford et al (2002).

Resource combination leads to changes in how activities are managed, coordinated, and creates a need for each firm to contribute to a specific value to the SC (Gadde, 2004). Firms are becoming more specialized in particular areas and therefore resources need to be shared between the interdependent parts of the SC. It exists a change in how resources are controlled and shared between the firms, leading to new ways to improve and recombined them in innovative ways.

The new evolving business network is putting the relationships between the actors in the SC in focus Ford et al (2002). It results in an interdependent network where all firms are accountable but also directly in line with the business outcome. Individual firms need to focus not only on their expertise but on how they rely on each other. Gadde (2004) continues that this change is increasing the pressure on a greater alignment of the whole SC, becoming more flexible and a need for companies to realize they are part of a network where everything is connected. The same is also emphasized by Ketchen & Hult (2007), Ford et al (2002), and Fawcett & Magnan (2001). Such an evolving business network implies changes in how actors should deal with control, power, and conflicts in the network. Gadde (2004) these changes as follows:

Control
Companies are moving from that a focal company was in control of all the decisions in the SC into a cooperative and collaborative atmosphere where all members of the SC influence each other.

Power
Previously the power was also located at the focal company, e.g. how automotive companies informed all other parties in the channel what to do. Today all the members of the network have a greater effect on each other, and the joint power is greater. The author states that the joined power should be used to promote trust, commitment, and relational behavior. Creating and emphasizing partnership and strategical alliances that can be used to create positive ripple effects across the whole network. The interdependent power results in a “give and take” relationship that rewards good collaborative behavior (Ford et al, 2002).

Conflict
Traditionally the conflict was handled by the focal company and there where a “take it or leave it” culture. It might have resulted in less overall conflict in the SC because all the other firms had to follow the order. However, the change towards evolving networks has led to an increase in conflict between the different firms. This is something that the author describes as a beneficial effect because it leads to an incentive to collaborate and change, the conflict becomes constructive.

In summary, companies are moving from traditional channels to evolving networks where the firms integrate themselves better in a SC and specialize themselves in their core strength (Gadde, 2004). Fawcett & Magnan (2001) states that this is the natural progression of SCM and that companies need to think more closely about the different building blocks that are intertwining them. A final note from Gadde (2004) is that not all relationships are worth perceiving. Firms always need to think about this according to the author. It is one of the biggest challenges for evolving networks. Dubois et al (2004) strengthen Gadde (2004)'s view on network relationships. The authors are stating that actors should be able to "choose" the best actors to form their network context through collaboration. However, this is harder than it might sound for companies to execute practically according to the authors. Dubois et al (2004) continue that an important role for a company in an evolving channel is to understand its own role within that network and how its activities are interlinked with other companies. A visualization is contextualized in figure 3.

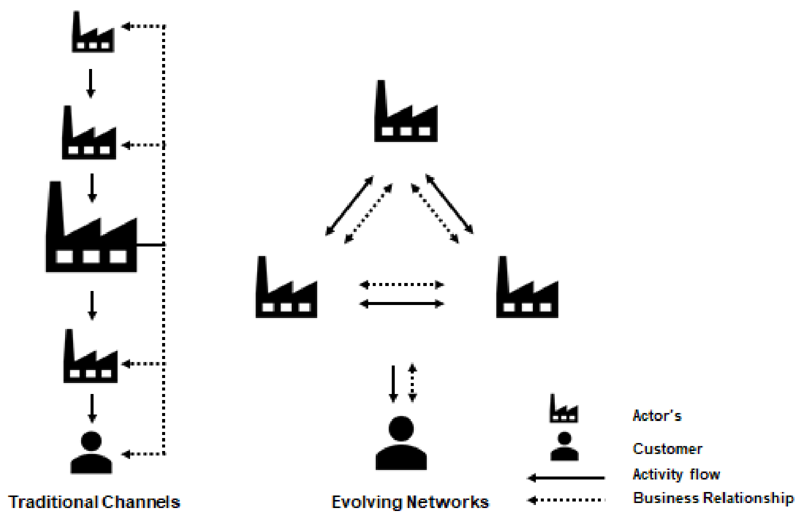

Figure 3 - Moving from Traditional Channels to Evolving Networks.

3.2.3 Network Positions & Horizons

Holmen & Pedersen (2003) discuss that for a company to be successful they need to be aware of their network position. Furthermore, the authors explain three concepts that clarify a company's relation to its network including the network -environment, -horizon, and -context. The network environment is the total business environment that a company operates in, this includes actors that the company is not aware of to exist. The network horizon is the part of the network which is relevant to the company and influences them both indirectly and directly. Lastly, the network context the company's in direct contact with the firm. As mentioned by Håkansson & Snehota (2006), "no business is and island" which is a fundamental part of SCM previously mentioned. According to Holmen & Pedersen (2003) the business strategy of a company needs to be synthesized not only internally or with a supply chain view, but through a network perspective. The authors continue that a company's possibility to understand its own network position and dynamics between firms is a central part of a company's long-term business success.

Holmen & Pederson (2003) argues that a company should analyze and actively make choices to adapt its network context to fit their business goals. Håkansson & Snehota (2006) states that company's need to firstly think of their own business interest first and not intertwine and align themselves too much in a specific network to reduce the possibility to be disrupted. Holmen & Pedersen (2003) argue that it is important for a company to have a self-interest but if they can influence the network to work together towards a common objective, they can create synergies not possible by themselves. The authors describe it as a paradox of network strategizing (strategizing is how to strategically align the network). This view is also shared with Dubois et al (2004) who state that companies should not aim to control interdependent firms in their network but instead influence them and to create synergies through "useful collaboration".

Holmen & Pedersen (2003) continue that to create an internal success as Håkansson & Snehota (2006) stated the company needs to think about their network horizon. Therefore, companies need to question themselves in their network position. Which firms do they want to create further alliances with and who do they wish to remove from their network? It generates a questioning about which firms they should collaborate with to be able to create beneficial synergies. According to Holmen & Pedersen (2003) this is what network strategizing is all about, to map the company's surrounding horizon and see how each part of that network effects the other firms. Dubois et al (2004) share the same viewpoint; SC performance does not only come from the company by itself. Actors in the network that are not performing should slowly be replaced with new actors willing to align themselves to the common goals. This is a question of being able to influence actors in the network.

3.2.4 Supply Chain Integration through Supply Chain Management

Several articles state that SC integration is crucial for a company's success in the area SCM. However, there is a lack of concrete guidelines on what SC integration infers. Fawcett and Magnan (2001) explain that SC integration consists of four different phases and the integration-maturity between companies in the network can vary. The first SCM-integration initiative is internal where the processes between different parts of the company are linked and provide cross-functional benefits. Secondly, backward integration is when the collaboration with 1st-tier suppliers are created and improved. Sometimes it also results in a 2nd-tier initiative, however, often it stops at 1st-tier. Thirdly, forward integration is where the focal company tries to integrate 1st-tier customers in their SC-processes. Lastly, completely forward and backward integration where the focal company tries to connect fully upstream and downstream. This type of integration is seldom found in practice amongst companies but could however have a huge impact on a company's SC.

Fawcett & Magnan (2001) continues to recognize that the collaborative competition between SC members is something that has gained a lot of attention during the last couple of years. However, the authors imply that even if companies today often state they want to create "end-to-end" transparency across the whole SC many are not close to being there. Fawcett & Magnan (2001) is stating the theoretical concept of SCM and argues that perfect SC does exist. The authors explain that SCM-integration can be broken down into three different stages. Firstly, SCM should work as an incubator to increase the speed and quality of information between the different members of the chain/channel. In theory, SCM should enable an increase in the total performance of the SC through collaboration. Secondly, SCM should recognize that a SC is built up by different building blocks, necessary to be integrated and aligned. For example, information systems, integrative organizational processes, common objectives, and shared metrics. Practically this demands a collaborative investment which makes its real-life application slower in practices than theory. The third and last step is that SCM should be viewed as a culture that should permeate all the members of the SC. The different members should be thinking about how they choose their team-members and relationships, this will ultimately lead to total integration and fast information sharing.

Pagani & Pardo (2017) presents the idea that integration is accelerated through digital technology. The mindset that Fawcett & Magnan (2001) presents is still valid, the integration process can, however, be improved according to Pagani & Pardo (2017). The authors state that today's digital capabilities have changed how integration can be made between suppliers, producers, and customers. The authors continue to explain this with the help of the Industrial Network approach previously explained in section 3.2.2. The activities and resources being shared between companies today can be simplified, something we have already experienced as this has rapidly changed in our personal lives according to Pagani & Pardo (2017).

3.3 Supply Chain Complexity

Serdarasan (2013) explains that SC's are complex networks of actors and the complexity is increased by their involvement in many interactions, processes, and relationships between each other. The author continues to explain that complexity is not necessarily related to a SC being complicated, as most see it. Instead, complexity focuses upon the interdependency throughout the chain. Serdarasan (2013) explains that it has more or less become common sense that SCM is all about the management of the complexity. Furthermore, the author refers to academic articles and consultancy reports that clarifies that there is a strong link between a company's ability to handle complexity and its SC performance, emphasizing the importance of management regarding SC complexity.

There is one single definition of SC complexity, however, the following definition is presented by Serdarasan & Tanyas (2012) which consists of five attributes that synthesize SC complexity. The attributes influences can vary and therefore the complexity of SC's can vary.

1. *Large number of actors* – SC's consist of many actors (companies), which itself creates a complexity the more disperse the chain is between companies.
2. *Large number of activities* - The number of activities taking place between the actors (relations, processes, and interactions) adds to the complexity of SCs.
3. *Activities are dynamic* - Activities (and actors) are dynamic and can change at any time, contributing to complexity.
4. *Non-linearity* – Activities between actors do not linearly take place, various layers within the SC can interact and be involved with each other.
5. *Large amounts of information required to control the SC* – To control and handle the complexity of a SC a large amount of information is required to make sense of. Not only is it complex to process and draw the conclusion of the data, but collecting the information adds an additional layer.

Serdarasan (2012) and Bozarth et al (2008) distinguishes between two types of complexity, static complexity and dynamic complexity. Static complexity describes the type of complexity that is related to the structure of the SC. The authors explain this includes the number of actors and the structural links (processes, interactions, and relationships) needed to get a product into the market. Looking at the five attributes above, this is related to the first (Bozarth et al, 2008).

Dynamic complexity the authors explain is related to the uncertainty in the supply network. Where links are drawn to the other four attributes (2-5) above (Bozarth et al, 2008). Uncertainty is created due to that activities are dynamic and can change. Non-linearity generates new layers of the SC, contributing to complexity. A large amount of information is required to control the SC, creating uncertainty that the specific information and material flow is there. Therefore, creating a challenge to experience a holistic view of the company's collected information. Bozarth et al (2008) illustrate the two situations with an example. Firstly, the authors describe a situation where the only type of complexity is structural. Imagine an inventory management situation where the demand from the customer will never change, the supplier is perfectly reliable in their deliveries and lead times are constant. In that environment, the only complexity to manage is structural. However, this is seldom the case as uncertainties are apparent in every part of the chain. E.g. demand from customers, supplier reliability, and deviations in lead time which increases the complexity. Bozarth et al (2008) explain that random events over time contribute to dynamic uncertainties affecting e.g. supplier reliability, customer demands, and lead time deviations.

What is then the best way to deal with complexity to increase SC performance? Bozarth et al (2008) compare in their research dynamic and structural complexity to find out which has the largest impact on SC performance. The author's research shows that the dynamic complexity affects the SC performance more than the structural complexity. This is because static complexity only is related to the first attribute above (*"Large number of actors"*), while dynamic complexity is affected by the other four. Thereby, managing the dynamic complexity would result in the greatest SC performance improvement. The question remains on how to handle dynamic complexity. Research by Vachon & Klassen (2002), investigated the best way to handle SC complexity to increase its performance. The result shows that improvements in information flow in the SC and the technological improvements generate flexibility for companies. The flexibility, the researcher state is the best way to help to manage uncertainties (that is driving dynamic complexity), enhancing SC performance.

3.4 Information Technology in the Supply Chain

Mentzer et al (2001) state that information is one of the five flows in SCM, Chopra et al (2013) highlight that the information flow is crucial for the performance of the decision making in the SC's. Information Technology (IT) is a broader term for digital tools facilitating the information flow. IT in a SC should support decision-makers with valuable information and data analysis to improve the performance of their decisions.

3.4.1 Role of Information Technology in a Supply chain

Chopra et al (2013) argue that IT in the SC creates the possibility for different entities to integrate and coordinate with each other. The authors continue that IT works as a building block for a SC-manager to make better decisions based on facts rather than speculation. Chopra et al (2013) state that IT is a broad term that consisting of hardware, software, and the people that support the tools to analyze and utilize the technologies. To analyze and capture information is today a significant part of a company's success and its performance. IT should work as a driver for the SC where the analysis of information is key for the future success of the SC according to Chopra et al (2013). The authors state that there are four different criteria to measure a good IT structure in consideration of the SC.

1. *"Information must be accurate"*: To be able to set up a truthful view of what is specifically going on within the SC, otherwise the decisions will not be accurate either.
2. *"Information must be accessible in a timely manner"*: If the company does not have the information in the time it will be impossible to make decisions regarding a specific problem.

3. *"Information must be of the right kind"*: Collected data can be dirty, consisting of inaccurate or irrelevant parts. Such parts need to be cleaned (translated and interpreted) to the right kind of data. Otherwise, analyzes of the data will result in inaccurate results.
4. *"Information must be shared"*: For a SC to be coordinated efficiently and effectively all the different stakeholders need to make an action plan that aligns with the network otherwise the general business decision will be lower.

Furthermore, Chopra et al (2013) discuss how to think about IT practically in the SC. The selected IT system should address the company's "key success factors". Each company works differently, therefore, the IT systems need to be aligned to the critical parts of the specific SC of the company. It is important to take incremental steps in the implementation process and not take further steps than needed. The IT system should be used to support decision making and not make decisions.

Chopra et al (2013) continue that the importance of IT in SC will be increase and become a cornerstone for SCM in the future. The authors have analyzed three different SC-trends for the future. Firstly, software and the use of IT as a service will continue to develop. Secondly, there will be a drastic increase in the use of real-time data and availability and lastly an increased use of mobile technology that can be utilized flexibly across the SC.

3.4.2 Risk Management in Information Technology

There is always a risk associated with implementing and designing new IT solutions for a company's SC according to Chopra et al (2013). The larger the proposed change is, the greater the risk of something negative to happen. The authors continue that the more integrated, connected and coordinated SC members are through a common IT system, the larger the consequences are if it would fail. The authors divide IT risk into two different categories. Firstly, the implementation of a new IT system can take up resources from both business and technical staff. It is no easy transition and requires a dedicated staff to make it done properly. If integration is not done properly it will result in a negative ripple effect for both the focal company and its SC. The second category is that the more reliant a company becomes on an IT system, the larger the consequence of failure is. If all SC decisions are based on data analysis it is of the highest importance that the IT system can live up to that pressure. Chopra et al (2013) mention these two categories as something managers need to think about. Literature can sometimes seem naive that IT implementations in the SC are a single happening and event however, successful IT implementation requires hard work and dedication from all members of the SC and the firms themselves.

3.4.3 Change Management in Information Technology

Todnem (2005) states that change management has become more than ever-present during the last couple of years for all types of organizations. Change is today happening faster than ever before. However, according to Todnem (2005) most organizations are underperforming on how to work with the change internally. Management in organizations tends to be reactive in the change process rather than proactive. Where the organizations try to mitigate and "contain" the outcome from large scale business projects. The author explains that the emergent practices for change are that change management should not be viewed as an individual single event for the organizations but rather a continuous open process for adaptation. Change is constant and organizations need to be aware of this and work with it constantly to prepare the employees for the unpredictable.

Van Der Meer et al (2006) discuss a change in major IT projects and that it is a key challenge for an organization to integrate employees and decision-makers in the creation process. For change management to work properly there is a need to align the organization with the goal of the IT-project. If the employees feels disconnected and not involved in the objective of the project, they can have a hard time adjusting to it when it is released. The author states that it is therefore important for organizations to have a plan on how they should work proactively with the change in consideration to the IT project.

3.4.4 Digitization vs Digitalization

Bloomberg (2018) explains that digitization and digitalization are often used interchangeably without an understanding of their underlying difference. The author quotes it as "digitization is the process of changing from analog to digital form". In a business context, this refers to the act of saving or moving something to a digital base.

Digitalization does not share a single definition as digitization. Bloomberg (2018) explains that digitalization is referred to a change of process based on a digital capability. Digitalization is used as an umbrella term for how digital technologies can change how business processes are conducted today. E.g. Gartner's definition is "the process of employing digital technologies and information to transform business operations" (Bloomberg, 2018).

4 Analytical Framework

In this section, the analytical framework used to develop the tactical strategy for Volvo Group's SCCT is presented. The analytical framework consists of two frameworks by McInter (2014) and by Supply-Chain Council (2012), a market analysis and company-specific information. Below, there is a clarification of what a tactical strategy is followed by a presentation of the two frameworks. Then, the analytical framework is presented.

4.1 Description of Tactical Strategy

The objective of this master thesis is to develop a tactical strategy for a SCCT. In this section, the definition used of a tactical strategy will be provided. Before providing the definition, to understand its foundation, the concept will be broken down into two components tactic and strategy where each component will be defined.

Firstly, what is strategy? There is a consensus between researchers there are several different definitions and ways to view strategy. Baraldi et al (2007) compare various definitions. The authors start with Ansoff's (1965) definition who uses a systematic process to generate a rational plan of how the company should reach a certain goal. Porter (1996) describes strategy as a form of positioning and how all underlying activities should align themselves towards that unique position. Whittington (2003) views strategy from a bottom-up perspective where the strategy should permeate through the day-to-day operations internally in the company. Baraldi et al (2007) state that all definitions of strategy have their own strengths and weaknesses. Where certain definitions are internally focused others are externally focused. According to Baraldi et al (2007), it is therefore important to understand what the company itself wants to achieve before choosing a strategy and how it might affect the business outcome from that type of decision. The conclusion is that strategy is a concept and can be viewed from many different angles. This thesis has chosen to use the definition provided by Johnson et al (2011) who simply defines strategy as "*the long-term direction of an organization*" and focuses upon the basic principle of what strategy is rather than how it is developed.

What is then tactic? Balaman (2019) defines the tactical decision to be more short-term than strategical. The tactical decisions have the ambition to fulfill and work to achieve the strategy. The timespan for a tactical decision the author explains is between 6 months up to a year. Balaman (2019) provides examples of a tactical decision in every-day supply chain operations, two of which are production capacity planning and material resource planning. Thereby, tactical decisions can be seen as a break-down of the strategy into smaller more short-term pieces.

The tactical strategy is in this master thesis is a concept which combines tactic and strategy to provide a holistic view. A tactical strategy is in this thesis defined as the design and prioritization of the tactical steps needed to fulfill a strategical plan. The tactical strategy should aim to achieve the best possible business outcome. In a SCCT context, the tactical strategy uses the strategy of the SCCT and breaks it down into manageable steps (tactics) that are prioritized to achieve the best possible business outcome. Thereby, the tactical strategy provides a more holistic and achievable view than strategy and tactics alone.

A criterion to develop a tactical strategy is to know the SCCT-strategy for the specific company. Without the knowledge of the SCCT strategy, tactical steps and prioritization can't be conducted. The tactical strategy needs a strategy to work as an objective and set a direction in which direction to head. Therefore, to develop a tactical strategy, there is a need to develop a SCCT-strategy.

4.2 Supply Chain Control Tower

This section starts to present the background of what a SCCT is and what its objectives are. Then, a framework describing which components the implementation of a SCCT consists of is presented.

4.2.1 Background

SCCT is one of many names describing the same concept. E.g. McInter (2014) describes it as Supply Chain Visibility while Trzuskawska-Grzesińska (2017) describes it as a Control Tower. The authors are referring to the same concept but under a different name. In this master thesis, Supply Chain Control Tower (SCCT) will be used as an umbrella term.

The objective of a company is to maximize the business outcome. McInter (2014) explains the correlation between a SCCT and the business outcome. SC operations are one of many factors that influence the business outcome and SCCT is one of many factors influencing the SC operations. This highlight the objective with a SCCT; to improve the SC operations and thereby the business outcomes. In what way the SCCT improves the SC operations, McInter (2014) explains the SCOR performance attributes (presented in section 4.3) is one way to measure SC operations and to provide an understanding of what a SCCT should strive to improve.

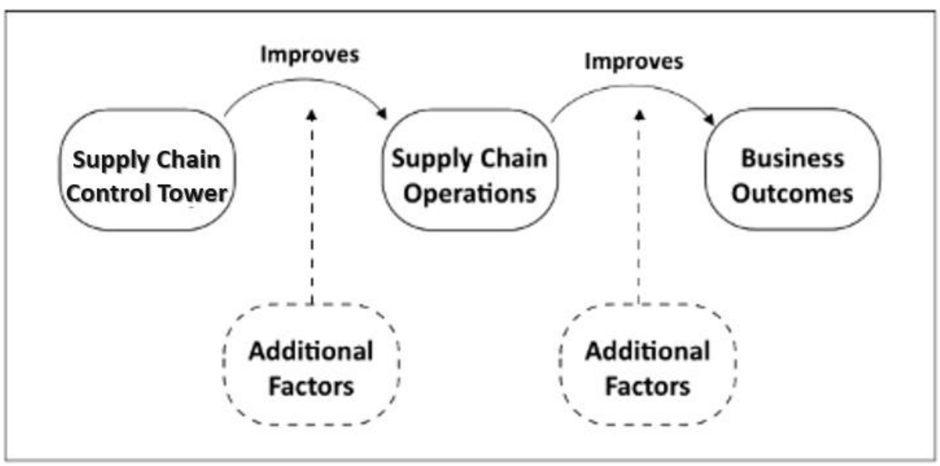

Figure 4 - The link between SCCT initiatives and business outcomes. (McInter, 2014)

What are the then the fundamentals of a SCCT? To answer the question, three steps are presented, firstly an insight into why it is needed, secondly, what it could do, and lastly, how it is defined. Trzuskawska-Grzesińska (2017) states that a major challenge for SC practitioners is to handle risks that are associated with uncertainty throughout the SC, e.g. uncertainty of demand and supply. To handle uncertainties in the SC, Trzuskawska-Grzesińska (2017) states two critical actions are the solution: visibility and control. The authors state that this could be achieved through a SCCT solution. A SCCT generates visibility by collecting and centralizing data throughout the SC in a system that provides a holistic view. The system could potentially with its width of data be used to find divergence in plans and forecast future events. Thereby, the SC can start to work proactively and react earlier to divergences. In the future, the author states that a

SCCT could be able to act autonomously, detect divergences, and proactively handle the situation through a critical business approach. Trzuskawska-Grzesińska (2017) further states that the need to generate visibility and control of the supply chain increases with supply chain complexity. Now, with an understanding of what a SCCT is and why it is needed, the definition used in this master thesis will be presented by McInter (2014):

> *"Supply chain visibility is a process of collecting supply chain data, integrating it, extracting intelligence from it and using that intelligence to interrupt decisions in a cross-organizational supply chain-oriented context"*.

The definition gives a holistic view of a SCCT's capabilities and highlights four steps required to achieve its full capabilities. It is important to note that there is not one single standardized way of how to implement a SCCT because all companies are unique and have various degree of complexity. To exemplify, Trzuskawska-Grzesińska (2017) analyzes three companies and found that the objective with the SCCT had varied in all cases (The various objective were balancing supply & demand, the shipment flow and inventories). Different objectives with the SCCT lead to the fact that a SCCT often look different and is used differently for various organizations. The data needed and the level of integration of data throughout the SC will look different depending on the business objective of the SCCT. Similarly, which kind of business intelligence and which decisions to interrupt will vary. For this reason, the definition of a SCCT needs to be more fluid and adaptable depending on the change of business objective. McInter (2014) provides a definition that is adaptable for various business objectives and can be customized to fit specific companies' challenges. The author continues that a SCCT project is not one single project but is incrementally implemented during different development stages divided into multiple projects.

4.2.2 Development process of a SCCT

McInter (2014) divides the development of a SCCT into four parts. The four parts are (1) *"... collecting supply chain data..."*, (2) *"...integrating it..."*, (3) *"...extracting intelligence from it..."* and (4) *"...using that intelligence to interrupt decisions..."*. In this section, each part is explained through scorecards presented by McInter (2014). The scorecards use a grading scale for maturity within each category. It is developed to be used to compare various SCCT solutions, however, in this master thesis, it is used as an indication of the maturity of a SCCT project. The higher the score on the grading scale, the better the SCCT initiative helps to improve the SC operations performance. Also, McInter (2014) defines three pre-requirements, fundamental for a SCCT initiative to succeed visualized in figure 5. These four parts of integration and its pre-requirements work as a foundation in understanding what is needed in the development process of a SCCT.

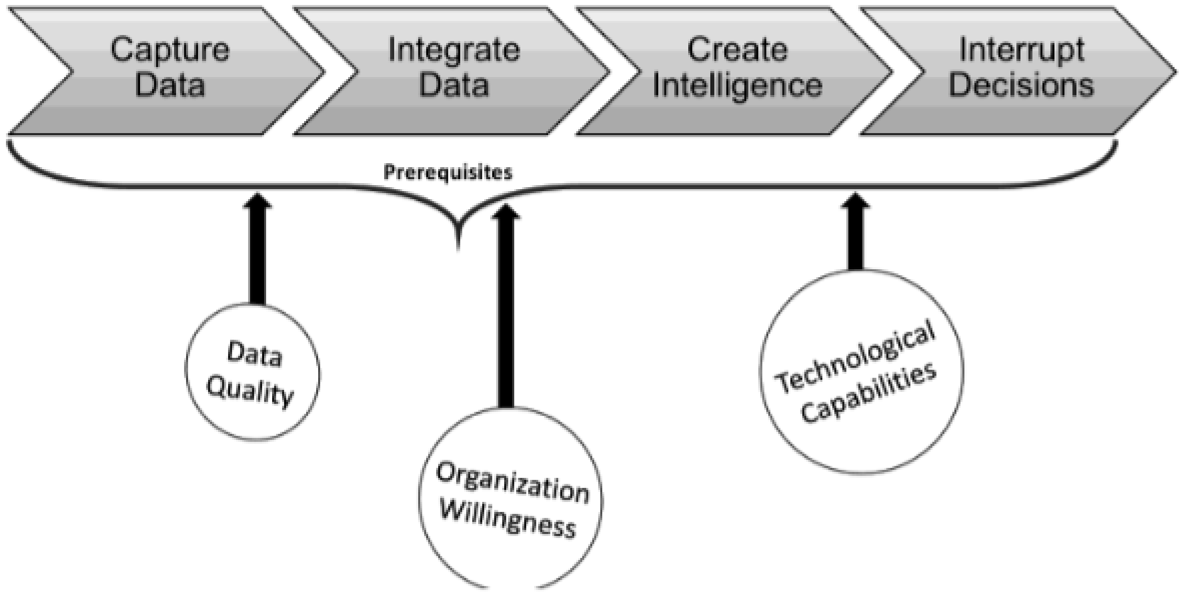

Figure 5 – Pre-requirements and the four components of a SCCT. (McInter, 2014)

4.2.3 Pre-requirements

McInter (2014) highlights that researchers have shown that certain factors correlate with the success of SCCT project. The factors are information quality, organizational commitment, and technological capabilities within the project.

Information quality is defined to be the degree that the information helps to fulfill the organizational needs (McInter, 2014). High information quality might be measured differently depending on the company. One company's organizational need might not be the same as another, depending on what the company needs the information for. The author also highlights that information quality is not equal to technological capabilities. Cutting edge IT might produce poorer information quality than what basic IT does. It is about the creation of a fit to technological needs. The author gives four dimensions that information quality can be qualified upon; accuracy, trust, timeliness, and usability.

Organizational commitment is defined as the willingness to put effort into the project and to make the changes necessary to succeed (McInter, 2014). The author states that research has shown that project failures are often related to a lack of organizational commitment. McInter (2014) states that companies doing project implementation seriously will often result in major organizational changes. Large changes require the company to show a true willingness for that change. The author states that organizational unwillingness can be a result of the uncertainties that the change will create. In conclusion, it is critical to understand that the SCCT project should not be the goal itself, but a means to fulfill a goal of the organization.

Technological capabilities are a pre-requirement for a SCCTs because it combines both organizational and technological resources. McInter (2014) continues that research strengthens this as a vital criterion for a successful implementation.

4.2.4 Step 1 - Capture Data

The first step is to collect relevant data needed to support the intended business decision (McInter, 2014). The author explains that the data should have an appropriate level of accuracy, free from bias, complete, timely, redundant, and have an appropriate level of detail. What an appropriate level depends on what is required to fulfill the intended purpose. The scorecard for data collection is presented in table 2.

Table 2 - Scorecard for data collection. (McInter, 2014)

Score	Description
0	No data is captured to support the target business decision.
1	Some relevant data is captured, but it is incomplete.
2	All data is captured but the accuracy of the data is unknown or known to be low.
3	Data is complete and consistently biased (i.e. low quality but predictable).
4	All data needed to support the decision is captured, complete, consistent, and measurably high in accuracy.

4.2.5 Step 2 - Integrate Data

The second step is to integrate the data and make it accessible for the users, who can be users in various parts of the company or SC (McInter, 2014). An important part because data is often kept in silos in various systems and databases both internally in the company and externally in the SC. The goal is to connect all data objects necessary to support business decisions, and there should be as few nodes as possible between data objects. This relates to the effectiveness of capturing data, as the better, the data is integrated the more effective the systems become. The scorecard to integrate data is presented in table 3 (McInter, 2014).

Table 3 - Scorecard for data integration. (McInter, 2014)

Score	Description
0	Data remains in the capturing systems with no attempt to integrate the data for later use.
1	Data remains in the capturing systems, but processes allow them to be manually integrated for ad-hoc tasks.
2	The solution integrates all the decision-relevant data, but not all of it is retrievable by decision makers.
3	Data is integrated and available to the decision maker, but not using the methods they prefer.
4	All relevant data is integrated and accessible by any relevant path the decision maker could use.
5	All relevant data is integrated, accessible, and the approach to integrating data is easily adapted.
6	All relevant data is integrated, accessible, and the integration approach is self-updating when confronting new data types or sources.

4.2.6 Step 3 - Create Intelligence

The third step is to use the collected and integrated data to process and retrieve relevant information. This category refers to how effective an organization is to generate information from the previous steps (McInter, 2014). The scorecard for the maturity of intelligence is presented in table 4.

Three areas outline how developed business intelligence is: (1) The system's ability to recognize events that need to be acted upon, (2) how simple the system is to update which events that need to be acted upon and (3) the system's ability to learn which events to update through feedback loops.

Table 4 - Scorecard for intelligence. (McInter, 2014)

Score	Description
0	There is no automated recognition from the solution that a business decision is needed.
1	Sometimes there is recognition from the solution that a business decision is needed.
2	The solution always knows that the business decision is needed.
3	The solution's approach to recognizing the need for a business decision is easily updated by users.
4	The solution's approach to recognizing the need for a business decision is self-updating.

4.2.7 Step 4 - Interrupt Decisions

The fourth step relates to the SCCTs ability to transfer the data and information and create relevant business decisions. A simple practical example could be that the system identifies a vendor not being able to deliver what is promised, which requires the system to select a new vendor from a list of vendors to offload capacity (McInter, 2014). The author continues that business decisions could also be strategical, e.g. to support the planning of logistical networks after an M&A. The scorecard for the interrupt decisions is presented in table 5.

Table 5 - Scorecard for disruption of business decisions. (McInter, 2014)

Score	Description
0	The solution has no explicit input to this business decision.
1	The solution is a required information source for the decision maker. A user decides how and when to make the decision.
2	The solution is a required information source for the decision maker. The solution decides when the decision is taken and the user decides everything else.
3	The solution offers a set of action alternatives based on the event, or
4	narrows the selection down to a few, or
5	suggests one action, and
6	executes that suggestion if the human approves, or
7	allows the human a restricted time to veto before automatic execution, or
8	executes automatically, then necessarily informs the human, or
9	informs the human only if asked, or
10	The solution decides everything and acts autonomously, with no notice given to humans except for debugging.

4.3 Supply Chain Performance Attributes

Supply-Chain Council (2012) presents the SCOR-model, which stands for Supply Chain Operations Reference Model created by the non-profit organization Supply-Chain Council. The author states that the ambition with the model is to help organizations to improve their SC processes. E.g. the model suggests appropriate SC structures for various types of companies, how to execute benchmark and compare best practices for SC processes. In this master thesis, most of the SCOR-model will not be presented, only the performance attributes will be used. The performance attributes clarify what creates a high-performing SC. In addition, metrics which decides how to measure the attributes.

Supply-Chain Council (2012) states that the five performance attributes are reliability, responsiveness, agility, costs, and asset management efficiency. In table 6, a definition of each attribute is provided.

Table 6 - The five performance attributes and their definitions. (Supply-Chain Council, 2012)

Performance Attribute	Definition
Reliability	The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the reliability attribute include: On-time, the right quantity, the right quality.
Responsiveness	The speed at which tasks are performed. The speed at which a supply chain provides products to the customer. Examples include cycle-time metrics.
Agility	The ability to respond to external influences, the ability to respond to marketplace changes to gain or maintain competitive advantage. SCOR Agility metrics include Flexibility and Adaptability
Costs	The cost of operating the supply chain processes. This includes labor costs, material costs, management and transportation costs. A typical cost metric is Cost of Goods Sold.
Asset Management Efficiency (Assets)	The ability to efficiently utilize assets. Asset management strategies in a supply chain include inventory reduction and in-sourcing vs. outsourcing. Metrics include: Inventory days of supply and capacity utilization.

Furthermore, Supply-Chain Council (2012) provides metrics for each performance attribute presented in table 7.

Table 7 - Metrics for each performance attribute. (Supply-Chain Council, 2012)

Performance Attribute	Level-1 Strategic Metric
Reliability	• Perfect Order Fulfillment (RL.1.1)
Responsiveness	• Order Fulfillment Cycle Time (RS.1.1)
Agility	• Upside Supply Chain Flexibility (AG.1.1) • Upside Supply Chain Adaptability (AG.1.2) • Downside Supply Chain Adaptability (AG.1.3) • Overall Value At Risk (AG.1.4)
Cost	• Total Cost to Serve (CO.1.001)
Asset Management Efficiency	• Cash-to-Cash Cycle Time (AM.1.1) • Return on Supply Chain Fixed Assets (AM.1.2) • Return on Working Capital (AM.1.3)

4.4 Presentation of the SCCT-Tactical Strategy Framework

In this part, the developed SCCT-tactical strategy framework is presented and explained. The framework consists of two parts. Part one, explains how to develop a SCCT-strategy. Part two, explains how to design a tactical strategy to align with the SCCT-strategy. The two parts are visualized in figure 6 and described below.

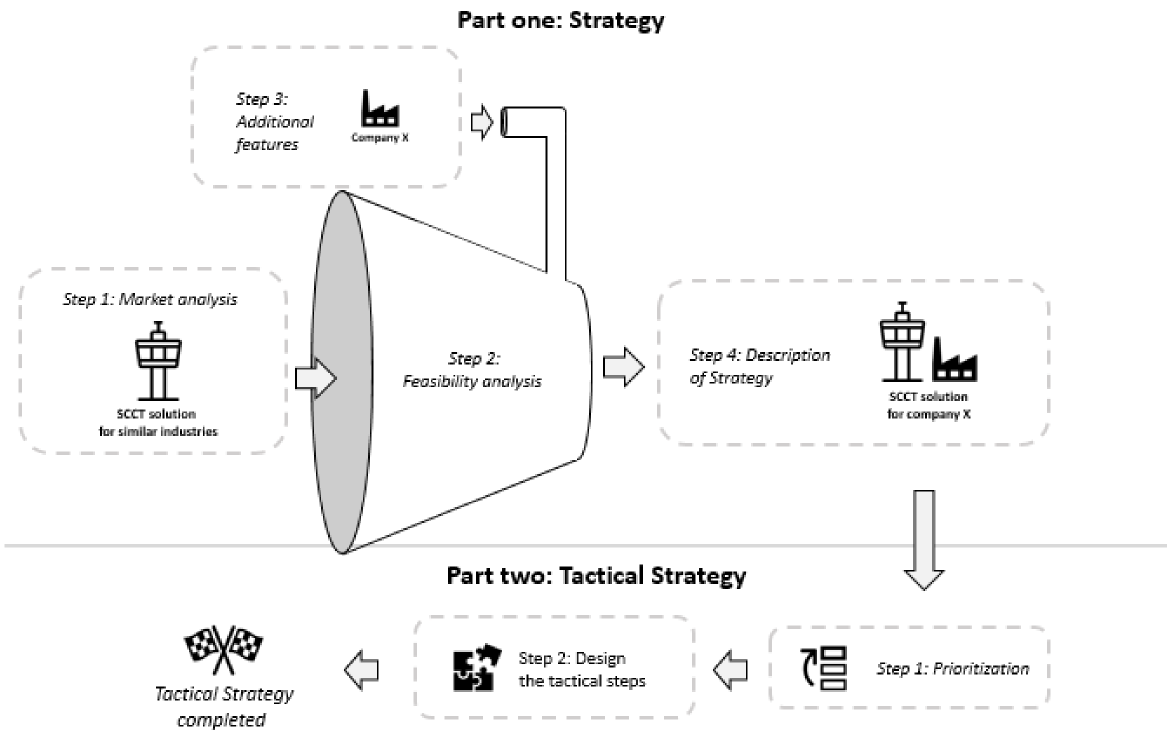

Figure 6 - Visualization of the two parts in the development process of the tactical strategy.

4.4.1 Part one – Strategy

The first part of the development of a tactical strategy is the need to develop a SCCT-strategy for the company. Without a strategy and an objective, the company cannot know in which direction to develop the tactical steps. The strategy consists of four different steps. The first three steps are used to create a feasible strategy for the company. The last step further explains and breaks down the strategy through McInter (2014)'s framework.

Step 1: *Market Analysis*

A market analysis is conducted by the collection of data from the industry. There are several different ways of how a company can conduct a market analysis and benchmark what reasonable SCCT-features are. A SCCT-feature is described as the different functions that a SCCT should have. There can exist a wide range of features that describes characteristics of what the SCCT should perform. Therefore, the market analysis should be tailored for companies in similar industries as the targeted company.

Step 2: *Feasibility Analysis*

A feasibility analysis is conducted by comparing the collected features from the market analysis and company-specific information. The company-specific information can be used to understand which features are reasonable and feasible for the company. The second step provides a reality and validity check.

Step 3: *Additional Features*
If the market analysis does not result in the expected features for the company's SCCT. The third step can add additional features to the strategy. The company itself can have company-specific knowledge which makes it possible to create previously unexplored features for their SCCT-strategy.

Step 4: *Description of Strategy*
In the last step McInter's (2014) framework is used to break down the strategy and make it tangible. Thereby providing a tangible objective to work towards. To create a tactical strategy the strategy needs to be broken down into an understandable structure that can easily be read and followed. The description of the strategy is a crucial part to understand and succeed with the creation of the tactical strategy.

4.4.2 Part two – Tactical Strategy

The second part of the analytical framework is the creation of the tactical strategy. The tactical strategy is based on the company's SCCT-strategy, the strategy and the objective were created in part one. The second part of the development of a tactical strategy is the prioritization and the creation of phases for the tactical strategy. Without prioritization there is no way to determine which tactical steps the company should take first.

Part two is designed in two different steps. The first step is to compare and describe how prioritization should be done for the features. The second step is the creation of the tactical steps needed to be done to achieve the tactical strategy.

Step 1: Prioritization
Prioritization is conducted by comparing how the SCCT features will affect the performance of the inbound SC according to the SCOR performance attributes. It is developed for the company to see the business outcome from each feature and therefore which to prioritize after the highest value. Secondly, to compare the SCCT-features with the company-specific knowledge to see which would generate a direct business value for the company. However, the business value of certain SCCT-features might not be possible to realize without fundamental features. Therefore, the prioritization becomes a combination of the SCOR performance attributes, company-specific knowledge, and logical reason.

Step 2: Design the tactical steps
The last step is conducted by compiling the prioritization in combination with company-specific knowledge about the company's SC. It generates a certain number of tactical steps needed to be done to achieve and create the tactical strategy.

5 Description of Volvo Group's inbound Supply Chain

In this section, a description of Volvo Group and the structure of the inbound supply chain is described. The section should give the reader a further understanding of the actors, activities, and complexity that exists today. The description provides the reader with important contextual factors relating to the inbound supply chain and challenges related to complexity.

5.1 Inbound Supply Chain

Volvo Group refers to the inbound SC as all activities taking place prior to their manufacturing plant. The start of the inbound SC is when raw material is extracted, and it ends when the refined material (or the raw material, if delivered directly) is delivered to Volvo Group's manufacturing plant. It is important to note, that Volvo Group seldom is directly involved in activities with actors behind the 1st tier supplier. Cases, when Volvo Group is directly involved with these, are for special material that is of critical business value.

5.1.1 Involved Actors

Several actors are a part of the inbound SC, below key characteristics are described of how the different actors are operating.

Volvo Group

Consists of several brands integrated through mergers & acquisitions into the Volvo Group family. This master thesis will focus on Volvo Group' Truck Operations (GTO) who manage all truck companies in the Volvo Group family. Volvo GTO corresponds to two-thirds of Volvo Groups revenue. Their manufacturing takes place in 18 countries across North America, South America, Europe, Asia, Africa, and Oceania.

Suppliers

Volvo Group's trucks are complex and consist of a large number of parts. The truck companies share a complex supplier base consisting of 5 000 1st tier suppliers globally. Even though the supplier base is large the supplier base is rather solid (infrequently change).

Volvo Group has the same approach and structure when handling a supplier. However, depending on the supplier's role for Volvo Group they can have different negotiation strategies and internal governance. Each supplier segment's importance is classified based on financial impact and supply risk, giving Volvo Group an understanding of the business impact of a supplier. Therefore, Volvo Group chooses to have different involvement in different relationships. The supplier's performance is continuously measured. If the performance levels are not fulfilled, Volvo Group will contact the supplier and work with them to ensure the performance level.

Sub suppliers

Beyond the 1st tier suppliers, there is a larger network of sub-suppliers (2nd and higher tier suppliers). Volvo Group has little contact and control over these suppliers, which is why all tier are clustered here as sub-suppliers. Volvo Group lets 1st tier suppliers manage their own suppliers base, thereby choose to outsource the control of their operations.

Carriers

Volvo Group is a global corporation where suppliers and manufacturing plants are dispersed, resulting in a need for a global transport network. All transports are outsourced to a large variety of carriers. In addition, for the best possible business outcome, there is a large variety of delivery concepts. A detailed description of the inbound logistics network is described below.

Cross-dock facilities

Most often, trucks are not filled up. Which is why consolidation of goods in most cases is performed at a cross-docking facility, to reduce transportation costs. The cross-docks is not owned nor managed by Volvo Group; they are contracted to consolidate material for Volvo Group. Therefore, the cross-docking facilities are utilized by other companies than Volvo Group as well.

5.1.2 Physical Flow

SC-operations are centralized between the sub-companies of Volvo Group. The transport management coordination between the sub-companies is also centralized. Being cost-effective is crucial for the physical flow in the SC-operations at Volvo Group. To achieve this, frequent pick-ups to reduce stock are utilized together with high filling rates to reduce transport costs. Which requires the need to consolidate shipping-volume together accurate planning. SC-operations are centralized between the sub-companies of Volvo Group. The centralization plays a vital part to achieve this, where Volvo can combine the strength from different brands to negotiate and create synergies in the physical flow. Figure 7 provides an overview of the inbound physical flow from 1st tier supplier to the plant.

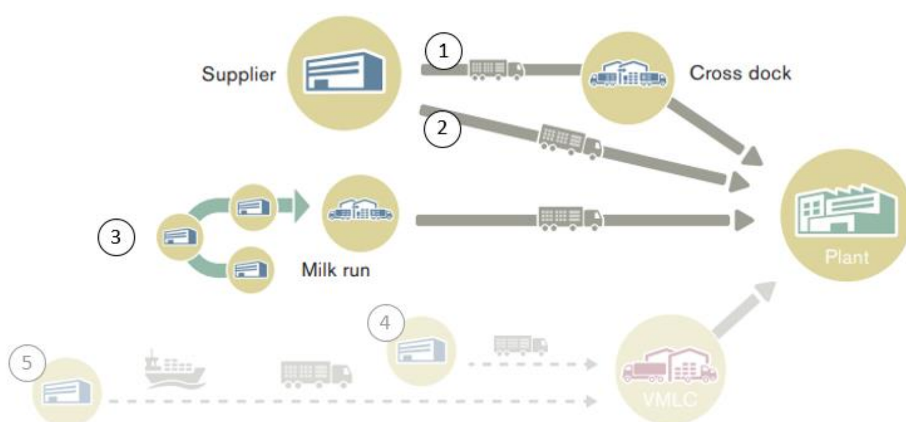

Figure 7 - Overview of Volvo Group's inbound physical flow. (Volvo Group, 2017)

Figure 7 visualizes five different physical flows used within Volvo Group. The physical inbound flow can be managed by Volvo Group or the supplier. Volvo Group managed flows are numbers 1,2 and 3 in figure 7, and supplier managed flow are numbers 4 and 5 in the figure. In the supplier managed physical flow, the supplier controls the transport between them and a Volvo Managed Logistics Center (VMLC) (used to minimize the inventory at the plants). In this master thesis, only Volvo Group managed flows in the inbound SC was observed, therefore numbers 4 and 5 in figure 7 will not be focused upon and are faded in the figure.

The first flow described in figure 7 is the most common physical flow. A cross-docking facility is utilized to consolidate or deconsolidate shipments. Consolidation is used to increase filling rates and thereby reduce transportation costs. In practice, it is used by merging less-than-full-truckload-(LTL) -carriers to full-truckload (FTL) and thereby reduce cost. Deconsolidation is used when a supplier ships an FTL which has goods going to multiple plants. The goods are sorted out at the cross-dock to consolidate with goods going to the same plant.

In all physical flows, goods can be transported by road, rail, or sea and be intercontinental, regional or local. The cross-docks described in this case are directly contracted by Volvo Group. There can exist multiple cross-docks used in the same physical flow. E.g. during intercontinental shipments, goods from a certain region's suppliers are consolidated, and the consolidated shipments sent to a common destination where the shipment is de-consolidated. This is done to minimize transportation costs and ensure FTL-shipments.

Cross-dock not contracted by Volvo Group can also be used, however, this is when the carrier companies use their own cross-docking facilities part of their own operations. They are called "hidden cross-docks" and are unknown by Volvo Group which results in an inability to influence or control them.

The second flow described in figure 7 is when a material supplier ships enough goods to send an FTL directly to a plant. This is the most cost-efficient transport flow.

The third flow described in figure 7 is when the flow of multiple closely located suppliers with LTL capacity is coordinated. One carrier picks up goods from multiple suppliers to increase the filling rate of the truck. The carrier then delivers the goods to a cross-docking facility to consolidate or de-consolidate.

The physical flows above provide insight into the complex nature of Volvo Group's inbound SC network. Volvo Group states the first flow as the primary flow for where the majority of the shipments are performed. As mentioned in the limitations in section 1.5, the first (the primary flow) is the physical flow observed and discussed in this master thesis. Figure 8 has been developed to clarify the primary physical flow.

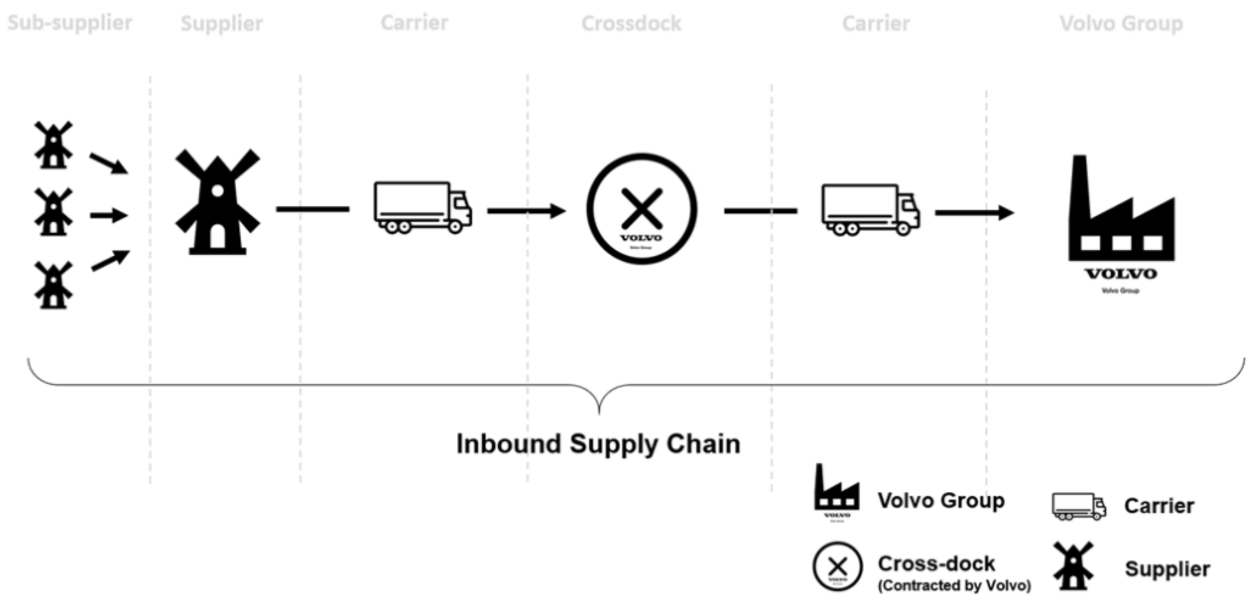

Figure 8 - Overview of the most common, the primary, inbound SC structure with a cross-dock.

5.1.3 Information Flow

There are large volumes of data that flow throughout the inbound SC of Volvo Group. In this section, a general description of how and what information is flowing in the inbound SC of Volvo Group is provided. Figure 9 presents a summary of this flow from the material supplier until the material reaches Volvo Group's facility. This figure includes the three main activities responsible for much of the information that flows; plan & book, perform transport, and monitor & react.

There is information shared within the transport network flow (between the suppliers and Volvo's plants/warehouses), the information collected consists of several checkpoints that are being shared by carriers and cross-docks in the inbound SC. The checkpoints are being reported manually. It is contracted that this data should be shared with a maximum of 24 hours of delay in the system. The transport network flow and the abbreviation are presented below in figure 9.

TBR – Transport Booking Request: No Booking, no pick-up; this is the basis to start transportation.
TBC – Transport Booking Confirmation: Verification from the carrier that the pick-up will be done.
PoP – Proof of Pick-up: Verification from the carrier that the transport order has been collected on-time according to booking.
PoA – Proof of Arrival: Carrier has arrived on time at the end destination according to the arrival schedule.
LC – Load Confirmation: If the material is passing through a cross-dock, the "load" is monitored up to the end destination (POA).
PoD – Proof of Delivery: Goods have been received at the plant. This triggers the payment to the carrier.

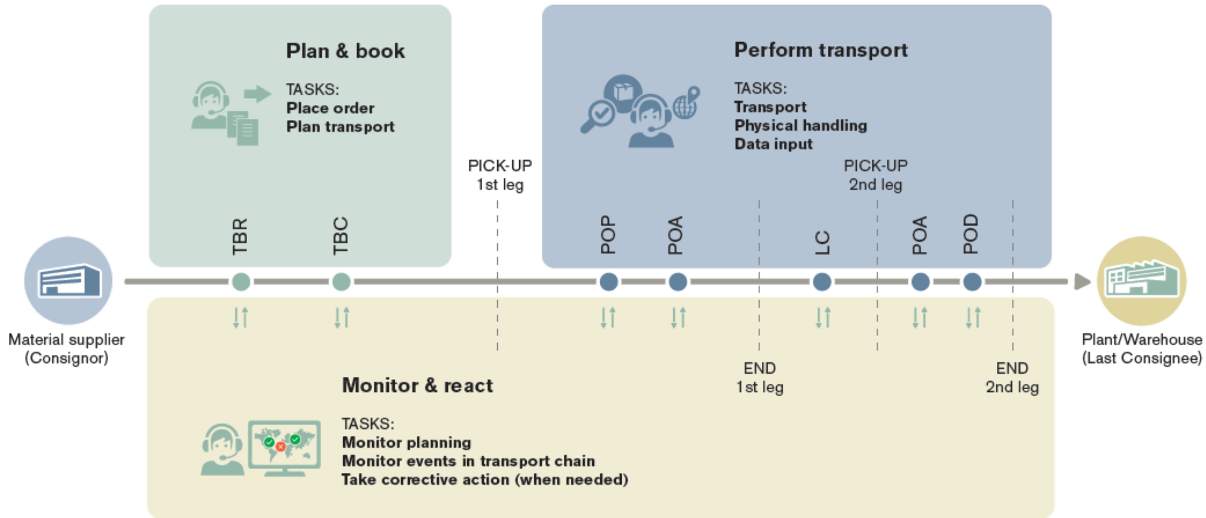

Figure 9 - Overview of events tracked and activities performed in the inbound SC process. (Volvo Group, 2017)

On the left side of figure 9 there exists a material supplier. The process described is that Volvo Group request material and the supplier accepts the request. Volvo Group then expects the process to be fulfilled. Today, no information is shared about the process status. Volvo Group first receives knowledge about the fulfillment or un-fulfillment during the PoP or if the suppler contacts Volvo Group manually to inform about the inability to deliver. The fulfillment performance for each supplier is being monitored manually by the different departments at Volvo Group. On the right side of figure 9 is a Volvo Group plant/warehouse. Each plant/warehouse has its own internal warehouse management system with an overview of their inventory status. Each plant or warehouse has its own individual system decentralized and operated individually.

One function presented in figure 9 is “Monitor & React”, which has the task to mitigate the effects of a SC deviation. This is done by manually comparing the planned shipments and collected data from the transport network flow. The user needs to decide whether there is a need to react to the deviation. Where more information about inventory status or the delay needs to be used to see the potential effect at the plant's production. The function is done manually where the user calls different departments and parts of the SC to individually collect information.

The previously mentioned function works as an example to describe Volvo Group’s information flow. The function highlights how to disperse information is within Volvo Group. It is not unique to this specific function. In Volvo Group there are large volumes of information but much of it exists in silos, stuck in separate systems. Volvo Group’s information flow is designed to be used decentralized. Where all processes are fine-tuned and matched to the decentralized design.

5.1.4 One Information Chain

Volvo Group is performing a project, One Information Chain (OIC), where they want to improve and centralize the information flow of the supply chain. They have been working on a first step where they combine the information flow for the ordering process and the material process to their suppliers and carriers. This first step was launched in early 2020. It has been launched as a pilot for Volvo Trucks Belgium with selected suppliers. Volvo Group is aiming to make it a standard and a requirement for all their suppliers that are connected to Volvo Group's inbound SC.

In the first step of OIC launched by Volvo Group they have digitalized the order-flow between Volvo Group and its suppliers. Volvo Group wanted to create an easier and standardized process for how orders from Volvo Group was received and accepted by suppliers. To do this, Volvo Group needed to standardize how both Volvo Group, suppliers, and carriers are reporting goods and volumes in their system. In summary, Volvo Group needed to recalculate all the packaging instructions to fit into how suppliers and carrier companies look at volume. Both Volvo Group, suppliers, and carriers had different systems for how they measured the number of goods. Resulting in that a supplier merely must accept the order made from Volvo Group and then an automatic order for a carrier is done through an integrated interface. Resulting in that the order-flow and material-flow from the suppliers are connected and digitalized into Volvo Group database. Therefore, creating a digital footprint of the inbound SC which is a first step for the SCCT.

It is important to note that the OIC initiative is not connecting to the suppliers and carriers' systems, but rather through an interface that lets them access and reports the needed information. Today there is no information whether the OIC should connect further upstream or generate more internal information from the suppliers and carriers.

5.2 Volvo Group's Supply Chain Complexity Challenges

In this part, the identified challenges connected to the inbound SC complexity is presented. The result is based on primary interviews with stakeholders connected to Volvo Group's inbound SC: The identified challenges are listed and sorted in table 8 on how frequently they were mentioned. A detailed description of each challenge can be found in Appendix I. The challenges originate from various positions in the inbound SC, a visualization of its origin is presented in figure 10. A summary of the key takeaways is described below.

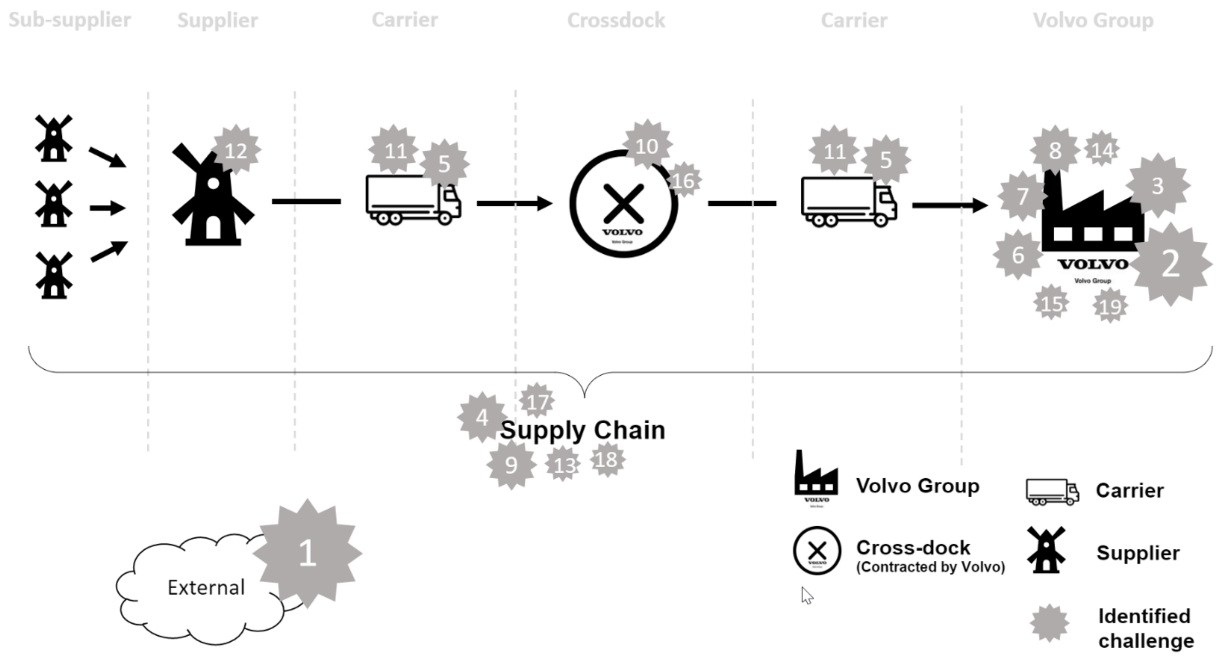

Figure 10 - Mapping the complexity challenges depending on where in the inbound SC they are located.

Table 8 - Complexity Challenges of Volvo Group's Inbound SC

Number	Challenges	SC Node	Specific Reason	Mentioned
1	External factors	External	External Factors	5
2	Data integration	Volvo	Data Integration Volvo	4
3	Change Management	Volvo	Change management difficulties	3
4	Capture data	Supply Chain	Capture data, generally	2
5	Capture data	Carrier	Lack of transportation data	2
6	Capture data	Volvo	Low-quality operational data	2
7	Regional Process Variations	Volvo	Regional differences	2
8	Culture	Volvo	Silos	2
9	Data integration	Supply Chain	Integrate data, generally	2
10	Data integration	Cross-dock	Lack of cross-dock integration	2
11	Deviation Reports	Carrier	Deviation Reports	2
12	Supplier Capacity Constraints	Supplier	Supplier Capacity Constraints	2
13	Deviation Reports	Supply Chain	Lack of deviation detection	1

14	Interrupt decisions	Volvo	Reactive problem solving	1
15	System Loopholes	Volvo	System Loopholes	1
16	Cross-docking process Variations	Cross-dock	Process Variations	1
17	Capture data	Supply Chain	Sustainable data	1
18	Capture data	Supply Chain	Financial data	1
19	Culture	Volvo	Acceptance of deficiency	1

5.2.1 Key Takeaways from the mapping of challenges

There exist four common themes in the complexity challenges found at Volvo Group. The four main themes are data-, process-, culture- and external- related. The themes are not weighted of their importance, instead, the objective is to provide an insight into the general themes which the identified challenges concerns.

General data problems

Relates to complexity challenges aiming to explain that there is a lack of how data is managed in the supply chain. There is a lack of data, lack of quality of existing data, certain data cannot be accessed and the integration of data across the supply chain and at Volvo Group is not complete. There is a consensus among the interviewees that it exists several different systems working well individually, however, there is a lack of integration between the systems. If data need to be combined between systems a lot of work can be required to gain the insights needed for certain tasks, and sometimes the data cannot be acquired at all.

Internal work process

Relates to the complexity challenges concerning Volvo Group being a large company with several departments and sub-companies. Different companies within Volvo Group have their own processes and standards. It creates a variation of the processes for the different companies. However, there are also process variations across the different actors in the supply chain. The current contract structure between Volvo Group and the carriers/suppliers gives the actors “wiggle room” to not follow the same standard for similar activities across the supply chain.

Working culture in a large company

Relates to complexity challenges originating from similar reasons as mentioned in the previous paragraph. Volvo Group is a large company where each sub-company and department has its own working culture. The company is built upon silos where each silo does not have a holistic view of the organization and how everything is connected/integrated. The large scale of Volvo Group affects how the company is working with change. Change is very slow-moving in the organization, where each silo is very “self” oriented. The culture and self “orientation” causes that cultural changes needs to be forced through the organization.

External factors

Relates to complexity challenges that affect the supply chain from an operational point of view. External factors can be divided into two different types. Firstly, factors that are very hard to anticipate from "logic", e.g. yellow vests, Covid-19 Pandemic, IT-shutdowns, etc. There is no pattern for how the factors occur but it's random and the effect on the supply chain can vary. The second one is constant external factors, e.g. traffic, weather, accidents.

6 Analysis of Volvo Group's Inbound Supply Chain

In this section, Volvo Group's inbound supply chain is analyzed and compared to the theory about complexity and network position & integration.

6.1 Complexity

The inbound SC for Volvo Group is highly complex. To explain how the actors are contributing to its complex nature, Serdarasan & Tanya's (2012) five complexity attributes will be used for the structure.

Large number of actors

Volvo Group's supply base consists of 5,000 suppliers, which is a large contributor to the complex supply structure. The supplier base does not count the network of countless sub-suppliers involved in the SC adding factor to the complexity. Volvo Group consists of several different brands that add to the number of actors in the SC.

Large number of activities

Volvo Group's work towards centralization of activities, however, due to Volvo Group's brand structure many activities are brand specific. E.g. Eicher- and Mack Trucks have various market niches where Mack is customizable while Eicher is a cost-efficient truck, resulting in several brand-specific activities which increase complexity. Another factor contributing to more activities performed is the cultural differences among the sub-companies. Cultural differences result in a large variety of activities being performed, increasing the complexity. Lastly, all suppliers manage their supplier network individually which results in a large variation (and thereby complexity) upstream.

Activities are dynamic (interdependent)

The attribute explains how interdependence between SC activities creates a dynamic variation between activities. Throughout Volvo Group's inbound SC there are deviations and processes not being performed as planned, making them dynamic. Volvo Group has safety mechanisms in place to be able to handle the dynamic nature of their SC, e.g. forecasts, buffers and ability to change their transportation structure (express orders) depending on the urgency of an order. Today, Volvo Group has a reactive approach when handling most deviations within the inbound SC. However, in some areas, forecasts are used for known phenomena's e.g. seasonal variations. In wintertime, ships have longer lead-times crossing the Atlantic resulting in a change in safety stocks. In most cases, there is no forecasting mechanism to be able to work proactively which is why Volvo Group today works reactively. It is, however, important to note that the SC structure is described as solid by Volvo Group's employees and that the SC structure itself is not very dynamic and does therefore not add any additional complexity.

Non-linearity

Volvo Group's inbound SC focus on the 1st tier suppliers to the manufacturing plant. Only observing this narrow part of the SC, non-linear attributes are observed. E.g. Volvo Group most commonly uses LTL carriers, resulting in trucks used being a part of other SC's, and thereby non-linear routes are taken between the supplier and manufacturing plant. Observing the cross-docks, there is not one linear process for how the goods flow through the cross-docks because they are all outsourced and the facilities operate in various networks, further explained in section 5.1.2. All of which contribute to increased complexity.

Large amount of information required to control the SC

Throughout Volvo Group's inbound SC there are large amounts of data being collected and processed. All data has not been centralized and therefore Volvo Group has had challenges to generate useful information of the existing data that flow within Volvo Group or throughout the SC.

To deduce the data and to track the information flow of the inbound SC, Volvo Group has conducted the OIC previously mentioned in section 5.1.3. The ambition of the project is to centralize the information flow between the order-flow between Volvo Group and their 1st tier suppliers. The project aims to facilitate a better understanding and control of Volvo Group's inbound SC information. The first step was to gain control over the data that was dispersed throughout the SC. However, there is still data that are not being collected, integrated, in inadequate quality or not used to generate valuable insights for Volvo Group, more on this in section 5.1.3.

6.2 Network Position, Horizon & Context

Volvo Group's inbound SC network horizon is massive both in geographical disbursement and number of actors. In the industry Volvo Group operates within, it is common among competitors to share the same suppliers. Resulting in an intertwined and connected network between competitors. The competitors do not only share large parts of their network horizons but also have overlapping network context. Volvo Group's network context consists of its 1st tier suppliers and its intermediaries such as carrier companies and cross-docks (that are not hidden). There is a potential to involve 2nd tier suppliers and upstream members who are critical for Volvo Group's material flow, however, today this is very limited and further upstream members are not part of their network context.

Volvo Group's network horizon is large and there are several actors that Volvo Group is aware of e.g. upstream suppliers, competitors, and carrier companies. Certain actors are more important to keep track of, e.g. upstream suppliers who are observed as critical for the material flow and suppliers who handle conflict minerals. The magnitude of Volvo Group's network environment is so large it is hard to describe, and as it will not add additional value in this master thesis this will not be attempted. A simple illustration of Volvo Group's network is illustrated in figure 11.

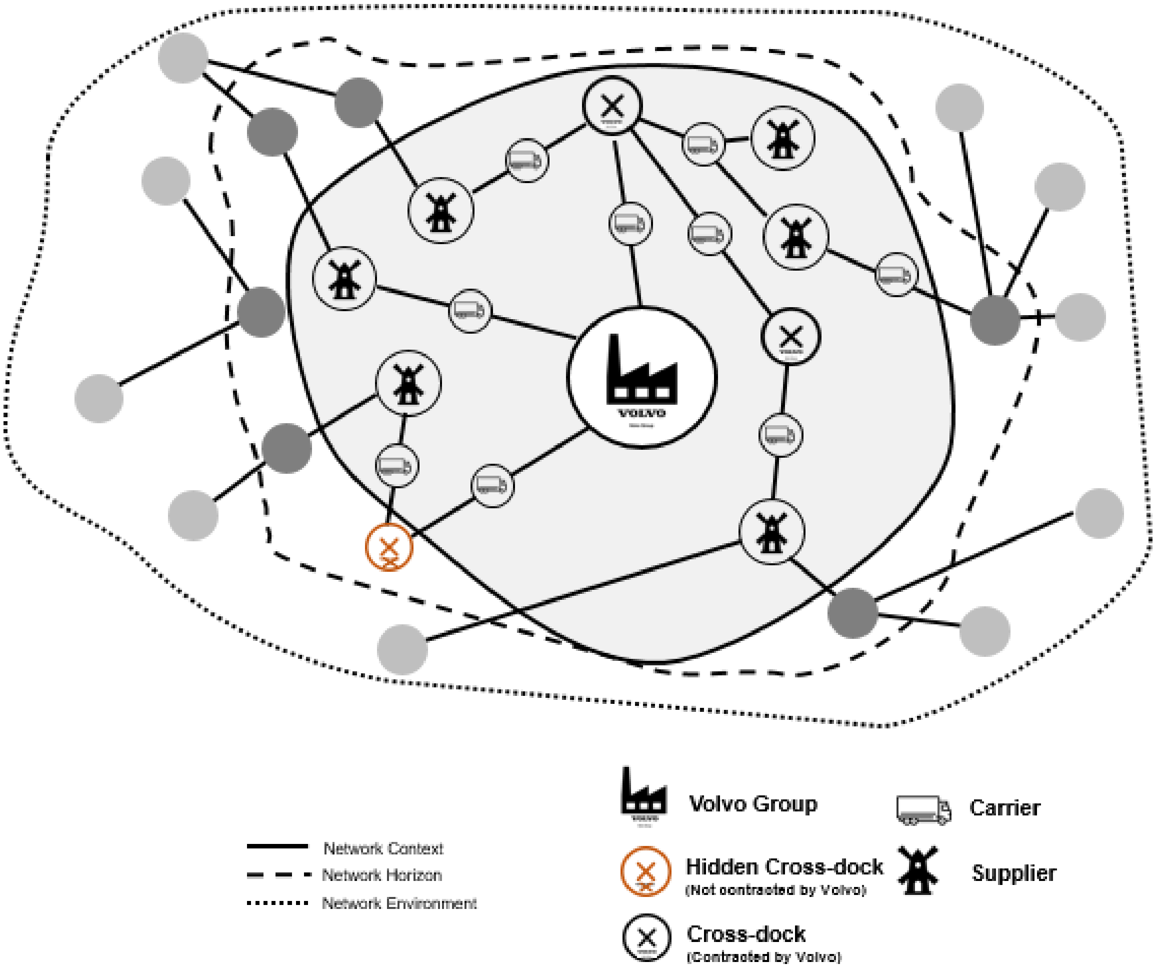

Figure 11 - Visualization of Volvo Group's network context, horizon, and environment.

There are reasons why Volvo Group has structured its network context in this way. One reason is that suppliers are supplying a lot of competitors. For instance, suppliers often do not want to share their information about the percentage of revenue that is based on Volvo Group or from competitors. Therefore, Volvo Group's insight in most of their 1st tier supplier base is considered low. Volvo Group is using control through contracting because the use of trust would be difficult when sharing suppliers with competitors. This could however also be an advantage where the suppliers can become very well adjusted to the requirements to stay competitive.

Gadde (2004) states that companies are moving from a traditional channel SC approach to evolving business networks. The business networks should be built on mutual relationships and a shared business objective. This view is shared with Ford et al (2002) and Fawcett & Magnan (2001) who all also state the importance of integrating and connecting to your network. The result from Volvo Group is that they are not being able to utilize their network position to integrate themselves to the full extent that the authors describe. It is not that Volvo Group does not have the willingness to integrate themselves further but that actors (e.g. suppliers) want to keep a distant relationship without insight. It also results in that Volvo Group does not have a direct connection to their sub-suppliers. Volvo Group is not actively working with the sub-suppliers at all.

It is important to state that Volvo Group has a structured approach to how they work with their supplier base. There are a lot of protocols and routines to maintain a supplier relationship and evaluate them based on performance. Volvo Group's supplier base is because of the routines rather stable and Volvo Group actively works to maintain the supplier relationship. Therefore, Volvo Group tends to work with suppliers to improve them rather than replace them when deliverables are not as agreed. Therefore, there is a form of trust in terms of the contract between each part, however, the insight into internal business low. In summary, Volvo Group is exercising control over suppliers because of the business environment in the automotive OEM industry. However, they actively try to work closer to suppliers by different steps, e.g. supplier evaluation, relationship management, performance evaluation, and audits.

Volvo Group is also using a similar approach to how to select and work with carriers. Where they are chosen depending on their geographical reach cost and ability to deliver. Carriers are managed by a central function for Volvo Group to keep costs down and consolidate volumes to ensure high frequencies. For this reason and due to the competitive factors in the business network Volvo Group is using a large variety of carriers to find the best performance at the lowest cost. Similar to how suppliers are contracted, Volvo Group has a framework for how to evaluate carriers on more factors than cost, e.g. sustainability, cost to make changes, and previous performance. However, it is hard to utilize this efficiently today.

The industry is highly competitive where the used practices in how networks are structured are minor, and suppliers are commonly shared. Since networks as similar, the internal capabilities of companies are what has generated competitive advantages. Thereby, networks compete as traditional networks where companies compete between each other rather than how the new evolving network approach described by Gadde (2004). In the evolving business network, Gadde (2004) continuous that this type of network structure for how to organize activities are stimulated by pull through integration and resources shared in the network. It creates beneficial innovative ways of the network that combines the resources to create value for their customers. This is still something that Volvo Group does and tries to manage. However, Volvo Group states that they are not utilizing trust and could further integrate themselves to reap further potential benefits. To achieve this there is a need to change the current structure of how Volvo Group handles suppliers.

7 Strategy for Volvo Group's SCCT

In this section, the first part of the analytical framework described in section 4 is used, where a strategy for Volvo Group's SCCT is being developed and presented. As previously stated, in this thesis a strategy is defined as "the long-term direction of an organization" (Johnson et al, 2011). This definition will in this case be related to the SCCT project. The long term-direction of Volvo Group (the strategy) is in this thesis presented by describing the scenario that should be strived to achieve in three years.

7.1 Step 1: Market Analysis

The concept of SCCT is a service offered by several consultant firms. In this chapter, solutions from what One Network (2020), Deloitte (2019) and BearingPoint (2020) describes as their top-of-line solution about a SCCT has been investigated. This section provides the summarized view of a SCCT and a selection of features is presented based on the consultancy reports. The selection of features was chosen with the criteria of what is deemed to be relevant for an inbound supply chain for an MTO/OEM-manufacturer.

The consultant reports share the same view of what the capabilities are with a SCCT. There is a consensus among the reports that the fundamental part of a SCCT is to generate end-to-end visibility in real-time by collaborative information sharing in the whole SC, from raw material to end consumer. The data can be analyzed to generate information about the status in the inbound SC. The SCCT creates a proactive work-method on how to act on deviation alerts in the inbound SC. The next step of development according to the reports is for the SCCT to function as decision support. It is when the user is not only notified about the need for a business decision, also the SCCT supports the user of what should be done. The decision support will present alternatives about the expected outcome of the deviation in terms of e.g. environmental impact or total cost. Lastly the SCCT final step is to autonomously take the decision that generates the most business value. Thereby, the SCCT can react to deviations and take decisions automatically of what generates the best business outcome. Deloitte (2019) provides a summary of describing the unified view of a SCCT: ".... is the "nerve center" of a live enterprise, which orchestrates and integrates decision-making across a company's operational capabilities".

The selected features relevant for an inbound SC for an MTO/OEM-manufacturer are summarized in table 9 and described below.

Table 9 – Summary of SCCT features identified from consultancies solutions that have the potential to be relevant for an MTO/OEM-manufacturer.

Potentially relevant features
Inventory status
Shipment status
Capacity utilization
Activity cost
Activity environmental "cost"
Performance

Inventory status
The feature indicates the inventory status. Various stock-keeping-units (SKU) often have different replenishment methods and the system can provide alerts if the status is not aligned with the inventory limits for the chosen method.

Shipments status
The feature is to provide information about the status of a shipment. If the shipment is late, the time of the delay shall be presented to the user. Such knowledge can help actors plan their day-to-day operations and to reduce the operational costs. By comparing the time of delay with the days of inventory provided by the inventory status, users can be notified to take appropriate actions to mitigate the negative impact.

Capacity utilization
The feature measures the capacity utilization of various actors within the inbound SC. With information about capacity levels, it is possible to both understand risks of bottlenecks which affects the physical flow and to understand where the capacity utilization is low. The feature can be combined with the shipment status to calculate if there is an increased risk of delay due to a capacity-restraint at a specific actor the inbound SC.

Activity costs
The feature presents activity cost options as decision support. By calculating what the cost of each activity is, alternative costs can be taken into consideration when making decisions within the inbound supply chain. E.g. if a truck is being two days late, the system alerts that the delivery is late and suggest typical actions to be taken. The actions could be continuing as planned and accept the delay or choose to order an expedited delivery. Each action implies different costs, and by summarizing the total costs. The user of the SCCT can decide the most appropriate action and act fact-based.

Activity environmental "cost"
The feature *is very s*imilar to the "Alternative Costs" above. The emissions for each alternative can be presented for better decision making by collecting and calculating the environmental impact of each alternative. Thereby, it also lets the user chose appropriate fact-based decisions.

Performance
This is a diagnostic feature where the performance of various parts of the inbound SC can be understood and optimized. Since a lot of data is collected and integrated into one system, the current performance, and past performance can be measured and compared in real-time. The past performance of various actors can be used as a decision basis when purchasing outsourced services. Root-cause analysis can be performed to understand why bottlenecks occur and how to improve them to reduce future errors. These are just a few of many examples of what can be done with the performance feature.

Shipping environment
The feature implies integrating the sensor-data that various transport modes can collect. E.g. many trucks have sensors built in to measure shock-levels, temperature, and humidity. All of which might affect the condition of the goods transported. With such data being collected, sensitive materials for certain conditions can be controlled during the transport to have been handled properly. If not, a relevant decision-maker can

be notified to investigate whether there is a risk of receiving damaged goods and if there is a need to take a proactive decision.

7.2 Step 2: Feasibility Analysis

A feasibility analysis is performed in this step, each feature found in step one will be evaluated of whether they are feasible or not in a Volvo Group context in the coming three years. The feasibility is based upon the data that has been collected during interviews at Volvo Group. The result is presented in table 10.

Table 10 - Summary of SCCT features deemed to be feasible for Volvo Group.

Potentially relevant features	Feasibility for Volvo Group
Inventory status	Feasible
Shipment status	Feasible
Capacity utilization	Unfeasible
Activity costs	Feasible
Activity environmental “costs”	Unfeasible
Performance	Feasible
Shipping environment	Unfeasible

Inventory status

The feature is deemed to be feasible for Volvo Group since the feature is more or less in place, but not integrated into a SCCT solution. Today, Volvo Group uses a range of replenishment methods for different SKU’s, the method is chosen based on the SKU’s characteristics. Inventory levels for the SKU’s are being collected, and there is a system notifying if the inventory level e.g. is running below a re-order point. A similar notification is performed for every replenishment method. Therefore, the requirements for the feature exists today, however, integration between multiple systems don’t. Important to note is that the quality of the inventory data has in some infrequent cases been incorrect due to human errors, resulting in running out of inventory.

Shipment status

The feature is deemed to be feasible for Volvo Group since it aligns with the OIC-project and it needs data that is already captured in Volvo Group’s inbound SC, see section 5.1.3. In the SCCT-project shipments are tracked by the collection of checkpoint-data. The objective is to observe whether a shipment has passed specific checkpoints between the supplier and Volvo Group. To be able to use the data in a SCCT, real-time data is desirable from when the goods pass through a checkpoint. However, today there exists a delay in the checkpoint-report. The checkpoint data-point can be reported with a slack-time of up to a day due to contractual agreements with carriers.

The consultancy reports highlight the need for real-time information on a shipment, and most commonly GPS-tracking is discussed in this case. There are two reasons why we limit the scope for Volvo Group to focus on checkpoints rather than the exact position that GPS-tracking would generate. The first and most important reason is that the business value of knowing the exact position rather than checkpoint-data has not been identified by Volvo Group. GPS-tracking is deemed to not generate business value worth its cost. The second reason is because of the contractual structure of the carrier companies. Often, LTL are used implying that the truck carries goods from other companies as well. There is seldom information of the intended carrier route between pick-up and drop-off. Therefore, the exact location would not add value since the estimated-time-of-arrival (ETA) cannot be calculated without information about the route. For this reason, the level of feasibility is limited to checkpoints.

Capacity utilization (Not evaluated further)
The feature is deemed not to be feasible for Volvo Group, despite the potential to be very useful. The ability to measure capacity from various actors and understand where bottlenecks occur (or is about to occur) at different stages in the inbound SC to elude potential disruptions. The feature would generate the ability to understand risk and integrate capacity with inventory- and shipment-status to get better fact-based decision support. However, the feasibility is considered low for Volvo Group due to the following reasons. Relationships throughout the inbound SC relies heavily on contractual agreements. The feature requires large contractual changes with several actors, which is a massive task. Also, to understand the requirements of actors and nodes within the inbound SC requires an integrated type of relationship with suppliers, which Volvo Group does not have today. The required relationship is not achievable in three years according to the interview objects. Therefore, the feature will not be evaluated further.

Activity costs
The feature is deemed feasible for Volvo Group since data about all costs are being collected. This feature would develop the capabilities of the previously described inventory- and shipment-features. It would improve the decision support and add another dimension to the SCCT. It could provide decision-makers with alternative costs to understand what the total SC cost is for a specific decision.

By collecting the cost of activities throughout the inbound SC, the SCCT-system can use algorithms to understand the cost of a chain of events. It is important to note that the exact cost of a specific event is a complex task to calculate. The collected cost data is not in formats that can be connected to specific activities, therefore there is a need to clean and make sense of cost data to do this connection, which can be demanding.

Simple calculation will be used to demonstrate how this feature could be designed. The feature presents the total cost of each decision for the decision-maker and give a cost-analysis for various decisions. E.g. if a deviation occurs at the supplier, the user would be presented with three different options. Firstly, order an express order (cost: X SEK), try to reschedule production (cost: Y SEK), or do nothing (Z % chance that production stops because of lack of inventory). Of course, cost is not the only factor that a decision is based upon, however, a central factor at Volvo Group.

Activity environment "cost" (Not evaluated further)
This feature is deemed not to be feasible for Volvo Group. The current difficulties to collect sustainability data throughout the inbound SC create the challenge to compare alternatives equally. The feature would be valuable for Volvo Group to be able to evaluate suppliers; carriers direct impact on sustainability. It would be used as a tool to factor in sustainability as decision support.

However, to implement this in practice Volvo Group would need to track, collect, and understand the environmental impact of each activity in the inbound SC. From the information that was collected from

Volvo Group this is not feasible in three years. However, the Volvo Group states that sustainable impact will become increasingly important for them. It will be important for Volvo Group to evaluate the sustainable impact of different actions across all its operations. Therefore, environmental impact across operations in the SC is something that Volvo Group will have to investigate further, however, in the SCCT context the feature will not be evaluated further.

Performance statistics
This feature is deemed feasible for Volvo Group. Performance statistics is the analysis of the collected operational data. The feature will analyze the data collected from the features in previous paragraphs. When the features of the SCCT develop, performance statistics will also develop because of the increase in collected data. The feature would make it possible for Volvo Group to evaluate deviations both on an aggregated and a targeted level with the collected operational data.

By such monitoring, alerts can be given for statistically assured deviations within the aggregated or targeted level. Thereby, increase the ability to quickly find root-causes of deviations and mitigate them. Another capability performance statistic would enable is the ability to perform probability analysis of certain events, by using historical data the probability of a deviation to emerge and the size of the deviation can be estimated. Such information can especially be interesting if marginal for errors are small and help understand the risks of errors to occur.

Today, operational data is dispersed or non-existent. The existent but disperse data requires to be collected and cleaned before processed, thereby no tool for performance statistics is currently being used. The feature could help support decision-makers on an operative, tactical, or strategical level.

Shipping environment (Not evaluated further)
The feature is deemed not to be feasible for Volvo Group for the following reasons. Firstly, there is a large variety of actors and transport modes used when transporting goods. Therefore, it is hard to guarantee whether all actors and modes collect the data. Secondly being able to access the data is not guaranteed since the data is dispersed at each carrier, and it is difficult to access the data due to contractual structure previously discussed. Therefore, the feature will not be investigated further.

7.3 Step 3: Additional Features

There were no additional features identified to add additional business value than the identified features from the consultancy reports. No additional features are added in this step.

7.4 Step 4: Description of Volvo Group's SCCT Strategy

In this section, McInter's (2014) framework was used to describe Volvo Group's SCCT strategy by its four steps "capture data", "integrate data", "create intelligence" and "disrupt decisions". In the first step "capture data", the data needed to be captured to support the identified feasible features. The second step "integrate data", describes how the data should be integrated. The third step and fourth step "create intelligence" and disrupt decisions" the four feasible features are combined to generate synergies. The synergies created between the features are described as new SCCT-features. In the third step "create intelligence" the logic behind features 1-7 is described. In the fourth step "disrupt decisions" the logic behind feature 8-9 is described.

The result was that Volvo Group SCCT-strategy includes nine features where features (5-9) are based on features (1-4) which were presented in part 2: feasibility. The structure for how the features are connected are presented in figure 12.

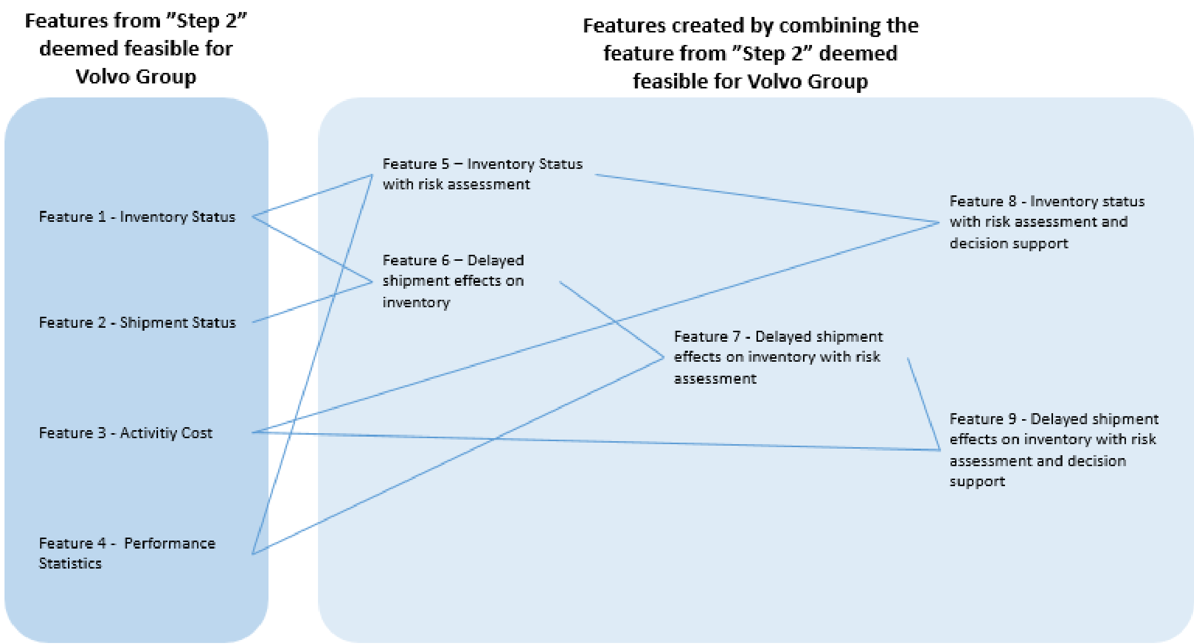

Figure 12 - Visualization of how the features deemed feasible from "step 2" are combined to create new features creating synergies between them.

7.4.1 Capture Data

McInter (2014) highlights that the capture of data should be relevant and of high quality to support the intended business decisions. For Volvo Group the intended business decision is to handle deviations within the inbound SC. Figure 13 describes the relevant data needed to be collected, and below the figure each data point will be described followed by an explanation of its current status.

It has previously been described how Volvo Group consists of a large supplier base, multiple carrier companies, and cross-docking facilities. The processes for the actors are not controlled or operated by Volvo Group. Thereby, the best-case scenario for each actor is for them to capture the data using their individual IT systems. To ensure the data's completeness, consistency and high-quality Volvo Group will need to continuously work to maintain the quality of the data as it is the foundation of the whole SCCT.

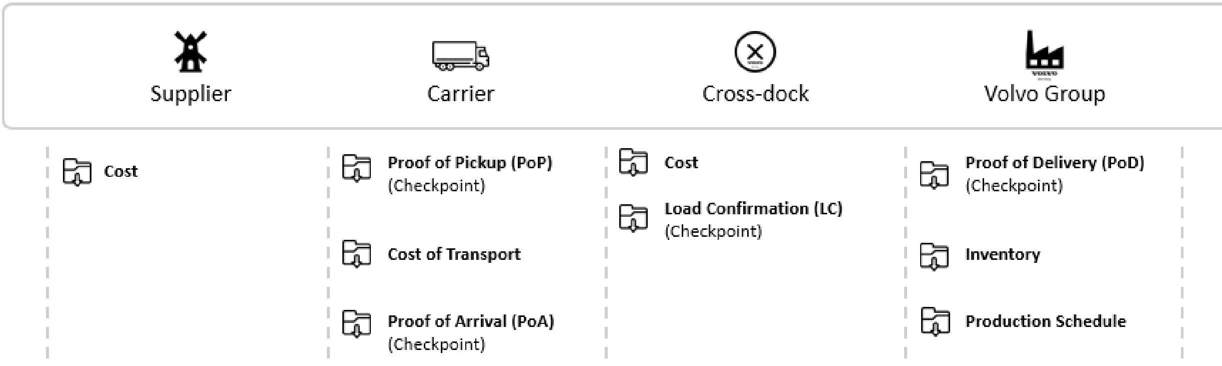

Figure 13 - Data that is needed to be collected with a high quality to support the intended business decision.

Supplier

There is one data-point identified at the supplier to support the intended business decision. This data point is the cost of goods, giving insights into what the cost of materials is. This is relevant information for a decision-maker, to support the decision which supplier to choose. Today, this data is captured but dispersed within Volvo Group, but it is not being utilized efficiently today. An increased utilization of cost data would require the data to be cleaned and connected to a specific shipment.

Carriers

Three data-points have been identified at the carrier to support the intended business decision. Firstly, PoP, which indicates what goods and when the goods have been picked up. Today, this data is being collected, however, there can be a large slack-time until reported. Therefore, the quality needs to be improved to support the intended business decision. Secondly, the cost of transport should be collected to understand what the cost is to transport goods with a specific carrier on a specific route. Today, this data point is being collected with similar issues as the previous "Cost" data point. Thirdly, PoA, which has similar issues as PoP.

Cross-docking facilities

Two data-points that are identified at the cross-dock facilities to support the intended business decision. Firstly, the cost of handling goods at the cross-dock should be collected. Today, this data point is being collected with the same issues as the previous "Cost data". Secondly, Load Confirmation (LC), which indicates what- and when goods have passed through the cross-dock. Today, this data point is collected, with the same issues as the previous "PoP".

Volvo Group

Three data-points are identified at Volvo Group to support the intended business decision. Firstly, PoD is collected and shares the same issues as the previous "PoP". Secondly, inventory data shall be collected to understand the inventory levels for each SKU. This data-point also includes collecting data about each SKU's replenishment method (type of replenishment method, ordering levels etc.). Today, the warehouses and plants collect and use the inventory data and replenishment methods to ensure the proper inventory levels. However, there are potential issues with the data quality due to human errors which cause incorrect inventory levels. Thirdly, data of the production schedule needs to be collected to understand the planned withdrawal from inventory. Today, this data is available an hour before the material is withdrawn from inventory.

7.4.2 Integrate Data

McInter (2014) states that the collected data needs to be integrated to make it accessible to users in various parts of the SC. The scorecard in section 4.2.5 state that the highest level of data integration is when all relevant data is accessible to all users in the SC, the integration and the approach of integration should be self-updating. Since most collected data will be dispersed at the various actors' IT systems and inaccessible throughout the Volvo Group inbound SC, the centralization of data to utilize in the form of one common system (the SCCT) is crucial.

The centralized system to integrate towards would imply that when the supplier updates the specific data-point in their internal system, it is automatically updated into the centralized SCCT system. Thereby, the integration would also be self-updating. Today, the situation is that information is very dispersed both throughout the SC and within Volvo Group. Multiple interview objects stated that integration of data is a large challenge in the day-to-day operations. Today it requires employees to use data from multiple systems. Also, in many cases the interview objectives state that data is hard to access because it is stuck in silos within Volvo Group and the SC.

7.4.3 Create Intelligence

With data being collected and integrated into the SCCT-solution, analytical tools to recognize the need for a business decision can be applied. McInter (2014) defines this step as creating intelligence to the SCCT, in simple terms is to make sense of the collected data and turn it into relevant information. The intelligence deemed to be relevant and feasible is presented below. It is important to note that the features identified in step 2 combine to create synergies, creating new features, see figure 14.

Feature 1 (Shipment status)

The first intelligence is to make the system understand which shipments are on time, which are delayed, and how delayed they are. It is done by using the collected checkpoint data. The checkpoint data is compared to the ETA at each checkpoint (the ETA is retrieved from manually inserted ETA's, based on historical data or planned times). If there is a delay, a control is performed whether the delay will cause implications downstream, e.g. missed planned transport from the cross-dock. If the delay will result in a miss of planned transports, the shipment status is set as "delayed" and a new departure is booked which generates a new ETA. With the new ETA, the time of the delay can be estimated.

The shipment status creates the ability to recognize the need for a business decision in the day-to-day operations and how to operate it more effectively. E.g. when Volvo Group receives incoming goods and the volumes of the incoming goods deviates from normal volumes, an alert can be generated to stakeholders to plan for this scenario. This is visualized in figure 14. Therefore, improve the day-to-day operations. The operational effectiveness can be increased as business decisions are based on facts. Today, there is a lack of knowledge about whether goods will be on time or delayed. The preparation for incoming goods today is only based on what is planned to arrive.

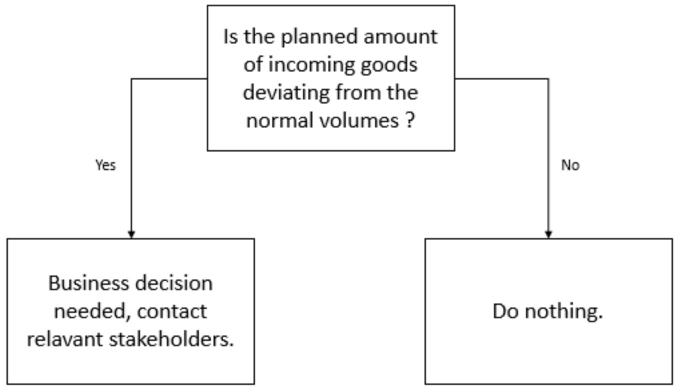

Figure 14 - Flow chart over how the need for a business decision is identified for incoming shipment volumes to Volvo Group's facility.

Feature 2 (Inventory status)
What is the current inventory and is the inventory within the limits (min/max) that has been set for the specific SKU's replenishment plan? If the inventory SKU's are outside of the limits, alerts are generated to responsible and affected users. The feature provides users with information that a business decision is needed. Figure 15 provides the logic of how the system is designed to support decision-makers. Today, Volvo Group collects its inventory levels, the replenishment methods, and its limits. Therefore, the feature is the development and integration of already existing systems and not the development of a completely new system.

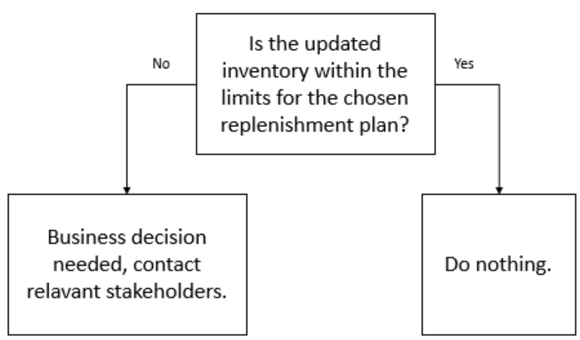

Figure 15 – Flow chart over how the need for a business decision is identified for inventory replenishment.

Feature 3 (Activity cost)
This feature is to connect cost data with the activities within the inbound SC. Two key abilities are created, firstly alarms are generated to relevant stakeholders to notify when prices are fluctuating abnormally to increase the awareness of large cost fluctuations, described in figure 16. The second key ability is to create better awareness regarding operational costs and activities in the inbound supply chain by generating statistics over activity costs. This increases the ability to detect areas with savings potential.

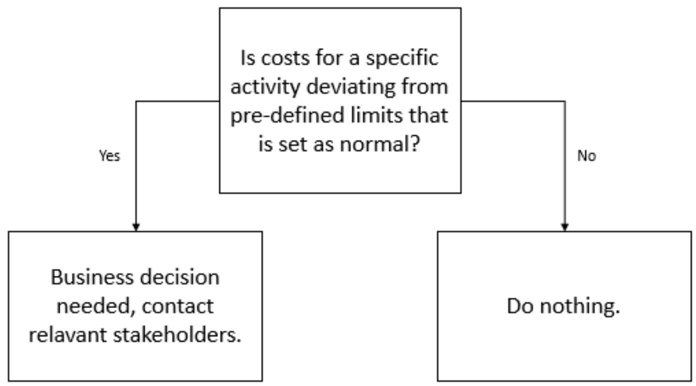

Figure 16 - Flow chart over how the need for a business decision is identified for deviating activity costs.

Feature 4 (Performance statistics)

Collected data should be stored and presented as statistics of the operational performance over time. The statistics functions as a diagnostic tool where statistically assured deviations throughout the inbound SC can be investigated and generate alerts when they emerge. This is visualized in figure 17. The system can recognize deviations that need to be addressed through a business decision. The statistics are aggregated in various ways, e.g. the overall inbound SC performance, the performance for a specific carrier, or a specific route. An example of how performance statistics will be used to recognize the need for business decisions is when there is a change in the trend of performance. If, the total performance for all carriers in France would decline rapidly resulting in a statistically assured deviation in performance for the region, relevant stakeholders would be notified to take a business decision. The root-cause could be due to roadblocks caused by the long-drawn yellow vest protests. The situation could result in a need to change safety stock limits for certain SKU's at French warehouses during the period.

The feature would generate the ability for decision-makers to be proactive in how they handle deviations. Another example is to use the performance statistics for risk assessment, previously discussed under "*delayed shipment effects on inventory*" above. Performance statics is today used for various suppliers on an aggregated level. However, the feature would support decision-makers not only to achieve aggregated data but on specific carrier routes. A carrier's performance level can vary e.g. between geographical zones and therefore the aggregated result can be misleading.

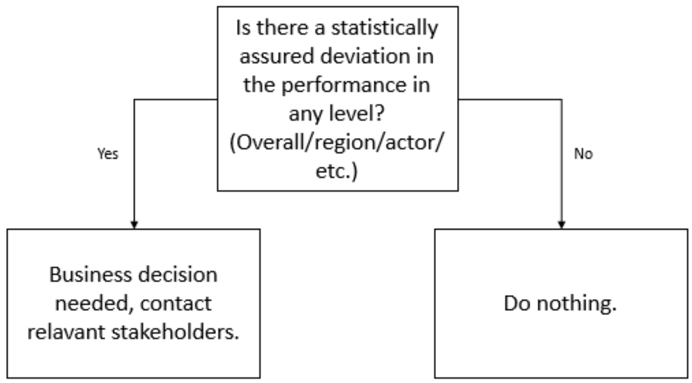

Figure 17 - Flow chart over how the need for a business decision is identified for deviating performance statistics.

Feature 5 (Inventory status with risk assessment)

This feature develops feature 2 (inventory status) by combining it with feature 4 (performance statistics), thereby a probability analysis based on statistical data can be performed. By utilizing data from the production schedule of what is planned to be retrieved from inventory, in combination with performance statistics of relevant actor's performance a risk assessment can be performed of risk of running out of stock. The logic is described in figure 18. Today, such a risk analysis is not in use in the current replenishment plan.

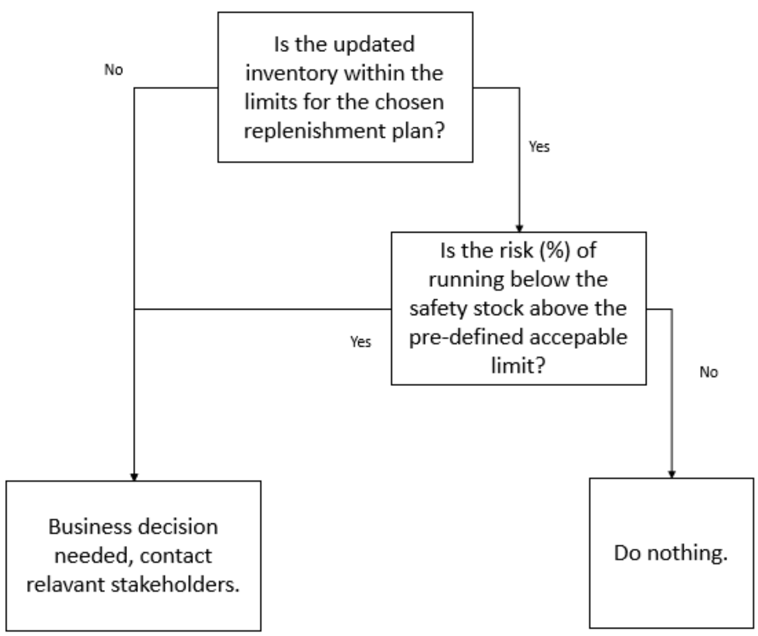

Figure 18 - Flow chart over how the need for a business decision is identified for inventory replenishment with a risk assessment. This is a development of feature 2 (Inventory status) and combine it with feature 4 (performance statistics).

Feature 6 (Delayed shipment effects on inventory)

This feature is a combination of the "shipment status" (features 1) and the "inventory status" (feature 2). The objective is to combine insights into how delayed a shipment is together with how long the inventory can last before a stock out. With this insight the system can decide if a business decision is needed for a certain delay or if it should be shipped without interference. The logic is described in figure 19. Today this is being performed manually, where delays are investigated by calling the potentially affected received to investigate if it will cause issues. However, interviews found that when something does not show up is often the first signal that a shipment is delayed. At that time, it is most often little to no understanding of how late it is.

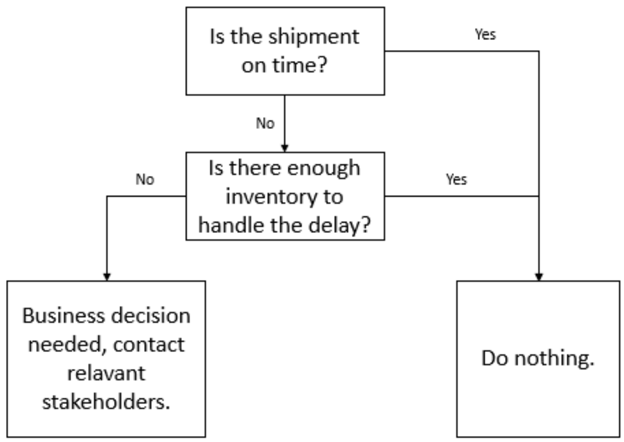

Figure 19 - Flow chart over how the need for a business decision is identified if a shipment is delayed. This feature combines feature 1 (shipment status) and feature 2 (inventory status).

Feature 7 (Delayed shipment effects on inventory with risk assessment)

This feature develops the feature "delayed shipment effects on inventory" (feature 6) by including a risk assessment. This risk assessment is based use historical data to understand if the shipment is further delayed causing the inventory to run out. If the calculated probability is higher than a pre-defined limit the relevant stakeholders receive an alert that a business decision is needed to mitigate the SC-risk. Figure 20 provides the logic of how a decision is designed to recognize a deviation. Today, such a risk assessment is not being performed.

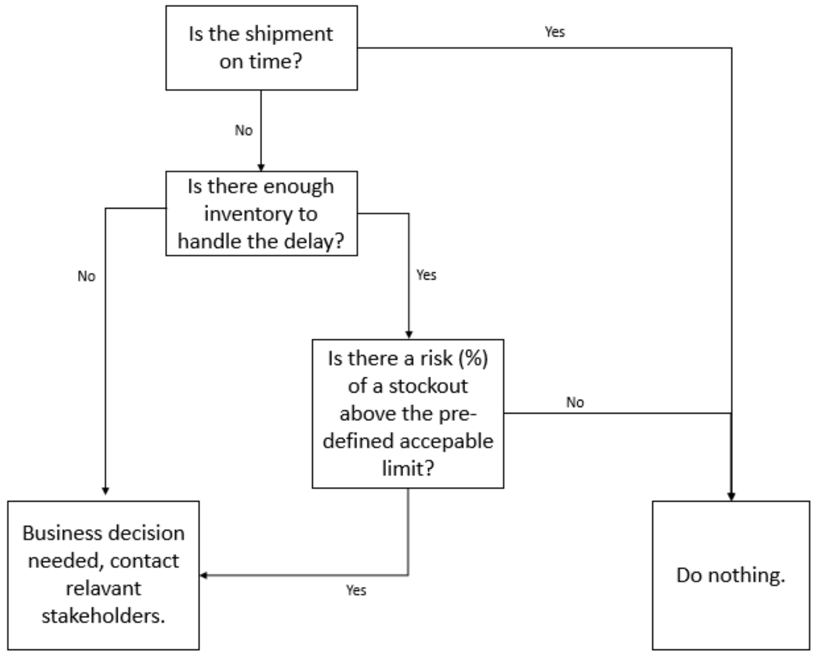

Figure 20 - Flow chart over how the need for a business decision is identified if a shipment is delayed with risk assessment. This feature combines feature 6 (delayed shipment effects on inventory) and feature 4 (performance statistics).

To sum up, with an ending note for this section, it is important to note that all "intelligence features" that have been described above are chosen since they can create synergies between each other, leveraging their impacts. Inventory status for example can be used individually (as it is today), however, the SCCT enables the integration of shipment status with the inventory status and creates new valuable insights and a way to work more proactively.

7.4.4 Interrupt Decision

Intelligence delivers the ability to recognize the need for a business decision. Interrupt decision is the fourth and the last step is to make the SCCT into a tool to support the decision-making process. The three-year strategy limits the level of advancements that Volvo Group can achieve because of lack of time and prioritization is needed. For this reason, the advancement-level in this fourth step is relatively low since the better value can be achieved in previous stages. Intelligence is developed to provide information to support decision-makers in the previous step. In this step, the information provides to support the decision-maker further regarding the outcome of the decision. The two interrupt decisions for decision-makers are related to "cost" and "probability of occurrence", to promote fact-based decisions. The two features connected to interrupt decision are presented.

Feature 8 (Inventory status with risk assessment and decision support)

This feature, to interrupt the decision-making process, is a development of "Inventory status with risk assessment" (feature 5) and combine it with "activity cost" (feature 3) for decision support. In a situation when there is a risk of stock out there is a limited amount of decisions that can be compared and evaluated. Five alternatives have been identified, which can be seen in the visualization in figure 21. Which alternative to take, depends on multiple variables. However, two important variables are "cost" and "risk of occurrence". Since the risk of occurrence is already calculated, the cost needs to be identified and presented to the user. Figure 21 is a visualization of the developed process, which includes the interrupt decision step. The decision-maker is presented with five alternatives where the calculated alternatives, “cost” and “risk” for each alternative is presented. Today, the process to decide when products shall be ordered is based on the replenishment method for a specific SKU. This is a well-developed process that is described to function well, however, in the decision-making process the alternative cost and risks are not evaluated resulting in a lack of fact-based decision making.

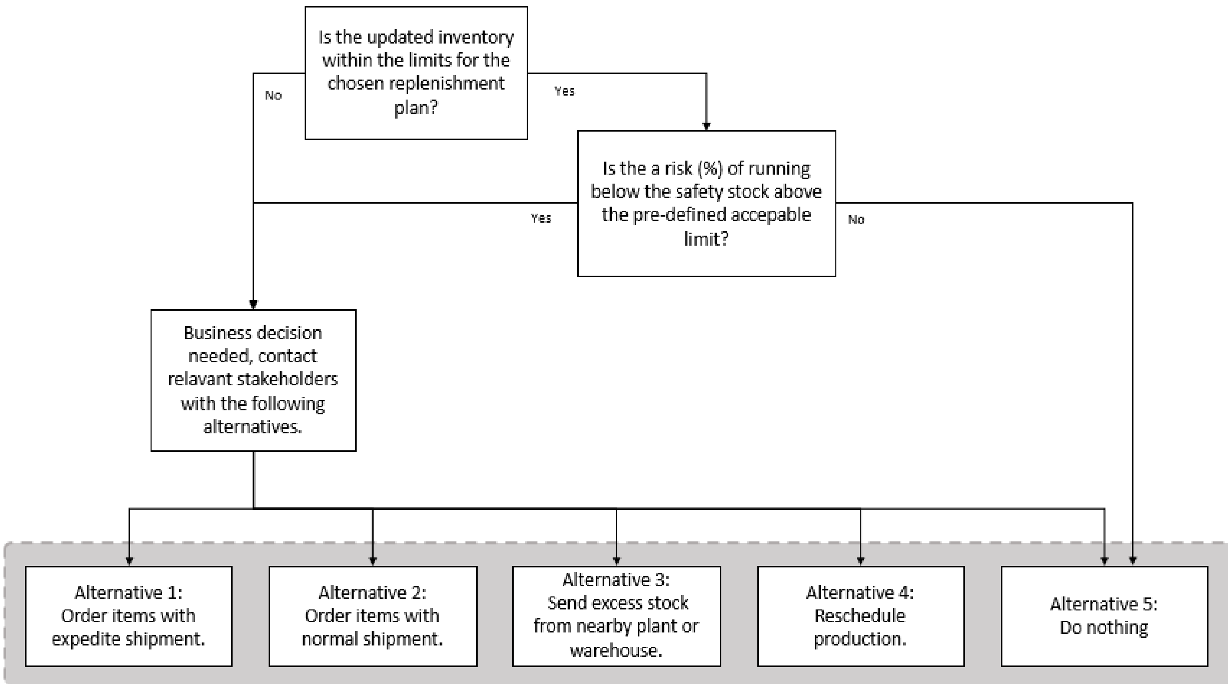

Figure 21 - Flow chart over how the need for a business decision is identified for inventory replenishment with a risk assessment and decision support. This is developing feature 5 (Inventory status with risk assessment) and combines it with feature 3 (activity cost).

Feature 9 (Delayed shipment effects on inventory with risk assessment and decision support)
This feature, to interrupt the decision-making process, is a development of “*Delayed shipment effects on inventory with risk assessment*” (feature 7) and combine it with “activity cost” (feature 3) and “performance statistics” (feature 4) for decision support. Similar to the previous paragraph, both “cost” and “risk” are two variables that are interesting for decision-makers to take a decision. The four identified alternatives to a delay are to set an expedited status on the shipment or do nothing. The developed process is presented in figure 22, which includes the interrupt decision steps. The decision-maker is presented with the cost of each alternative and the risk of deviation to occur, compared to the different steps. Today, neither alternative cost nor risk is further evaluated in the decision-making process. Instead the decision is taken upon what the direct cost of a transport is, the cheapest alternative is most often chosen.

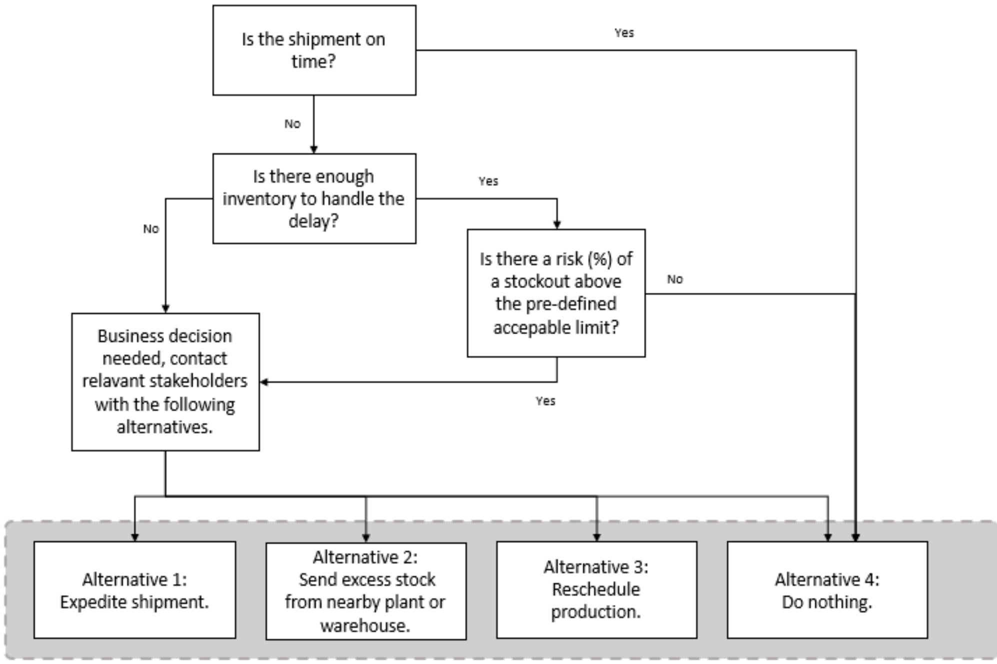

Figure 22 - Flow chart over how the need for a business decision is identified if a shipment is delayed with risk assessment and decision support. This feature develops feature 7 (delayed shipment effects on inventory with risk assessment) and combines I with feature 4 (performance statistics).

7.5 Summary of Features creating the SCCT-strategy at Volvo

In this section a summary of the requirements of the SCCT-features is presented in table 11. The SCCT-features in the table create together the SCCT-strategy. The table describes firstly, which data-points are needed for each feature, secondly, how the features are connected, and lastly, what type of system integration is needed for them to function. Firstly, which data-points are needed for each feature, secondly, how the features are connected and lastly, what type of system requirements is needed for them to function.

Table 11 – Summary of features, its required data points, and system requirements.

Feature	Data-points	Combination of features	System Requirements
Feature 1 – “Inventory status”	“Checkpoints”, “ETA/shipment plans”, “Production schedule data”	-	Compare checkpoint data with planned data
Feature 2 – “Shipment status”	“Inventory data (including limits, replenishment plants)”, “Production schedule data”	-	Compare inventory data with replenishment data

Feature 3 – “Activity cost”	“Cost data”, “Cost of transportation”, “Cost of activities (inc: limits)”	-	Create cost analysis for different inbound SC scenarios
Feature 4 – “Performance statistics”	“Continuous collection of inbound SC data”	-	Centralize and continuously collect information about the actors (aggregated & targeted)
Feature 5 – “Inventory status with risk assessment”	-	Feature 1 & 4	Calculate the risk of running out of stock
Feature 6 – “Delayed shipment effects on inventory”	-	Feature 1 & 2	Calculate delay of shipments effects on inventory
Feature 7 – “Delayed shipment effects on inventory with risk assessment	-	Feature 6 & 4	Calculate delay shipment effects on inventory with a risk assessment
Feature 8 – “Inventory status with risk assessment and decision support”	-	Feature 5 & 3	Calculate inventory status with risk assessment and decision support
Feature 9 – “Delayed shipment effects on inventory with risk assessment and decision support”	-	Feature 3 & 7	Calculate delayed shipment effects on inventory with risk assessment and decision support.

8 Tactical strategy for Volvo Group's SCCT

In this section, the tactical strategy is presented. The first step is to create a logical structure of which the tactical steps are and how they are prioritized. The prioritization is done by the usage of the SCOR performance attributes (presented in section 4.3) in combination with the identified complexity challenges. The SCOR performance attributes are used to explain how the features will impact the performance of the SC operations and the business outcome. The identified complexity challenges are used to clarify which features influence business value according to company-specific information. The second step is the creation of the steps in the tactical strategy, thereby, the formulation of the tactical strategy itself.

8.1 Step 1: Prioritization among features

Before the explanation of the feature's impact on the business outcome based on the SCOR-model and complexity challenges, there is a need to understand the difference between the nine features. The first four features (1-4) requires a collection of data (including high data quality) and integration of the data to make it accessible. The last five features (5-9) is, however, a combination of the first four features. It implies that there is no need to capture or integrate data. Feature 5-9 is combined features which require that feature 1-4 are developed properly for them to function at all. This creates a "chain of features" since features build on each other. Therefore, it is of great importance that proper data collection and integration is performed initially. If not, issues with the first features will result in issues in the "chain of features". See figure 23 to visualize how the "chain of features" is interlinked.

Features compared to SCOR performance attributes

To see how the features impact SC performance, the connection between the SCOR model and the "chain of features" needs to be taken into consideration. On the right side of figure 23 are the combined features. The features on the right side of figure 23 support decision-makers to receive information to take improved fact-based decisions. The advanced features have a higher level of decision-support which relates to a higher value on the SCOR-model. Total cost can be optimized, together with reliability and flexibility. As visualized in figure XX, the further the feature is to the right, the higher value it would generate for Volvo Group.

However, as mentioned in the introduction of this section. There is a need to create features 1-4 before the creation of feature 5-9. Therefore, even if the business value of feature 5-9 is higher they are still dependent on features 1-4.

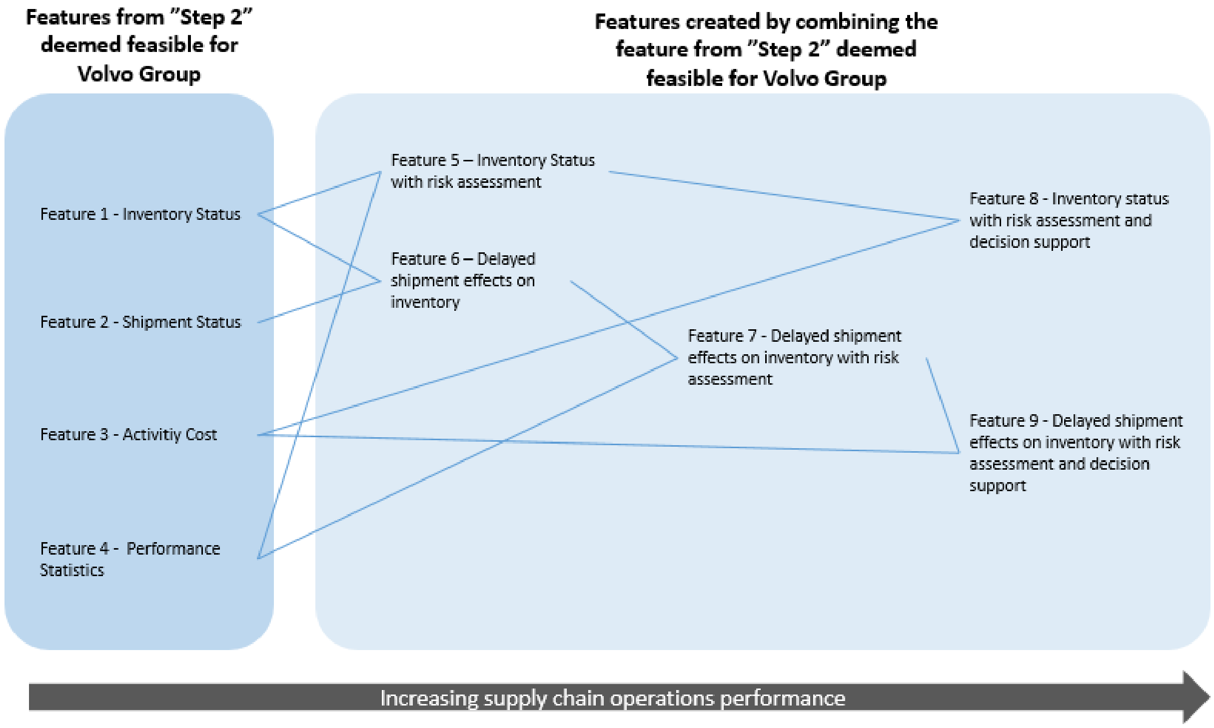

Figure 23- The more the features are combined the more support can be given to decision-makers leading to better decision making, resulting in improvement of the SCOR performance attributes cost and reliability.

Features compared to complexity challenges

How do the features influence the identified complexity challenges? There were two themes related directly to the creation of the tactical strategy, data- and process- challenges. The data challenges were related to data collection (lack or often low quality) and data integration. While the process theme was related to the lack of standard of processes across the different sub-companies at Volvo Group. The first four features need proper collection and integration of data. There is a need for a standard for how the data is collected and integrated into a centralized system. Therefore, the data- and process- challenges are addressed directly in the tactical strategy. However, the features are limited to specific parts of the inbound SC while aspects of the challenges are not addressed at all because it is outside the scope of the features.

Today feature number 3 ("activity cost") is currently not being used and therefore was not identified as a challenge. The features would not help to solve current complexity challenges within Volvo Group's inbound SC: However, it can generate a large impact of the SCOR performance attributes when supporting features 8 & 9.

8.2 Step 2: The Creation of the Tactical Steps

In this section the three tactical steps for the tactical strategy are presented. The steps are based on the prioritization of how the features contribute to SC operations performance and the complexity challenge in previous section 4.3 & 5.2. The three tactical steps are visualized in figure 24.

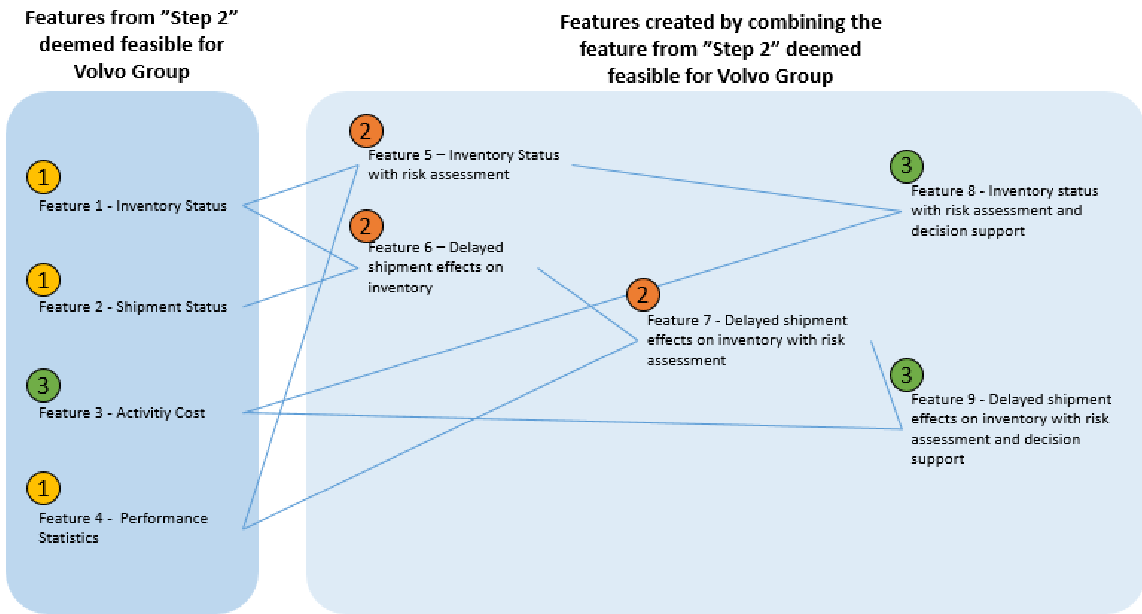

Figure 24 - The tactical strategy summarized with three tactical steps and its prioritization.

The first tactical step (The digitization step)

The first tactical step consists of features 1, 2, and 4. The first step can be described as the digitization step, since the objective with the step is to create and compile digital processes. All three features are currently being performed today, however, manually and not centrally. The first step will improve previous processes to be performed digitally, with a focus on better captured and integrated data. Data collection and data integration has been identified as large challenges. To create the features (1-3), data needs to be captured at a high quality and integration done properly between decentralized systems, see table 11 for specific information. The first tactical step is an important foundation for the development of the total SCCT and will improve SC operations performance compared to previous manual processes.

Feature 3, "activity cost", is not chosen to be part of the first tactical step. The "activity cost" feature was not identified as a current complexity challenge and without the creation of features 8 & 9 a large value cannot be identified from the feature alone. Therefore, feature 3 is not a priority in the initial tactical step.

The second tactical step (The digitalization step)

The second tactical step consists of features that are created through the combination of previous features. The features in this tactical step could not have been developed without the previous digitization step. This tactical step is the digitalization step because the created features transform business operations and generate capabilities for the SCCT to detect the need for business decisions. The SC operations and the business outcome can be improved because of the features. Multiple features are combined to support the ability to see complex links between inventory, shipment, and performance. The features create new capabilities for the inbound SC that did not previously exist.

To succeed with this tactical step, Volvo Group will need to carefully integrate different SCCT features and create logic and algorithms previously described in section 7.

The third tactical step (The decision-support step)
The third tactical step expands the digitalization step by utilizing the activity cost to understand alternative costs for various decisions and offers decision-support. This tactical step is described as the decision-support step which enables a new capability for Volvo Group. The alternative costs and probability analytics are used to improve decision-making.

To succeed with this tactical step, Volvo Group will need to understand their SC costs and connect the costs to different activities. Volvo Group will need to integrate the previously mentioned features into one centralized system where there are clear algorithms for how different decision-support is created.

Thee three tactical steps and figure 24 provide a summary of the tactical strategy for Volvo Group.

8.3 Complexity challenges at Volvo Group - can the SCCT help address them?

How does the potential features affect the SC complexity for Volvo Group? Features are presented and explained in section 7. Serdarasan & Tanyas (2012) presents the five attributes for SC complexity compared to the created features.

Large Number of actors
The SCCT-project or the features will not reduce the number of actors in the SC.

Large Number of activities
The number of activities is not reduced by the SCCT-project. However, the SCCT requires standard protocols and routines for how different activities are managed (collected and integrated data). Therefore, there will be a reduction in re-work and special cases related to the needed data. Each actor in the network will have to adapt to the compliance and standards that are set to make the SCCT features. However, there are certainly risks with this part of the SCCT implementation further discussed in section 9.3.

Activities are dynamic (interdependent)
The SCCT features will give Volvo Group a better overview of the activities in their SC and how they are performed in real-time. The inventory- and shipment status will improve visibility for abnormalities and functions as a proactive tool for deviations. The performance statistic feature will create transparency for which actors in the network are not performing and reaching the desired levels. Therefore, the actors can be specified, improved, or removed and result in a reduction of dynamic activities. In summary, activities will still be dynamic however the user will have better control of activities related to the features of the SCCT. The user will be able to see the interdependency between the activities.

Non-linearity

Serdarasan & Tanyan (2012) describes non-linearity as activities between actors which are not direct and that different actors interact and are involved in different SC structure. Therefore, there is not a common overview of how communication and interaction are executed. The SCCT works similarly to the OIC-project at Volvo Group which works to create a standard digital information flow. The SCCT-project will demand that the information flow is standard and there are clear processes for how information is shared. The SCCT creates a clear structure for linearity and how the authority would be traced and verified throughout the SC. The project needs to help foster a culture and standard for how to act in various situations.

The SCCT will require Volvo Group to create a standard for how data is transferred and collected from the SC actors. It will need to be done of high quality and continuously and self-updating. In the success of this, the SCCT will reduce non-linearity.

To create a higher degree of linearity Volvo Group needs to address the following challenges:

> "Change Management"*:* There would be a need to structure a plan on how to create the SCCT and get everyone onboard about the collective objective. Change management is further described in section 9.2 which explains what is needed from Volvo Group's point of view.
>
> "Process Variations": There would be a need to have a standard or clear directive of how the different sub-companies process functions. There would also be a need to create standards for how the different SC actors communicate with Volvo Group.
>
> "System Loopholes": There would be a need to remove system loopholes to reduce inaccurate information to enter the system.

In summary, several steps are needed to be executed to achieve linearity in the inbound SC at Volvo Group. However, to create a successful SCCT there is a need to address several of the linearity challenges. Therefore, a successful SCCT will improve non-linearity.

Large amount of information required to control the SC

Sedarasan & Tanyan (2012) continues that the collection and integration of information add another layer to the SC complexity. The OIC-project previously mentioned in section 5.1.3 shows that Volvo Group can create a digital foundation, to connect and combined data across the SC. The SCCT will result in that Volvo Group will acquire a clear structure for how the different actors should share data for the intended features.

To create a successful SCCT, Volvo Group will have to sort of a large amount of information. It is a key criterion in the tactical strategy and without proper integration, the SCCT will not be successful. To succeed with the tactical strategy and the intended features Volvo Group will need to structure its information network, therefore, the result will be a more centralized and manageable information flow.

Similar to the previous paragraph (number 4.) Volvo Group needs to work on some fundamental challenges described by the employees to reach this centralized information hub. The challenges that are related to this complexity attribute are all data related which has previously been discussed in result 5.2. Therefore, Volvo Group needs a plan on how to achieve the desired levels of engagement.

8.3.1 Summary

The SCCT itself would not improve the static complexity (1-2) mentioned by Sedarasan (2012). However, it could help reduce the dynamic complexity by the creation of a standard interface for interaction between different SC actors in Volvo Group's inbound SC. If the implementation of the project is successful it will create routines and clear guidelines for what each actor needs to do to follow "protocol". The OIC-project is a good start to prove that there is a success story on how to handle information and get an understanding of dynamic complexity in the inbound SC from a digital perspective.

However, to create a SCCT there will need to be fundamental changes to Volvo Group's information flow in the SC, how data is captured and integrated. Therefore, the SCCT might not answer to complexity itself, however, it helps Volvo Group to further understand where their inbound SC complexity issues are. Which will potentially lead to a SC with less dynamic complexity through the creation of the SCCT. Several of the SC complexity challenges are taken into consideration in the creation of the SCCT.

9 Discussion & Reflections

In this section, Volvo Group's inbound supply chain is discussed in consideration of the SCCT and which effects it will have on the business outcome. The SCCT is theoretically discussed from a network perspective to determine which factors that are needed for the success of a SCCT creation.

9.1 Volvo Group's Network Position's Influence on the SCCT

The reason why Volvo Group has chosen its current way how to "approach" the network was previously discussed in section 6.2. The first observation was that this network strategizing is in the opposite direction compared to what theory about SCM states. Many suppliers that Volvo Group is using is shared with their direct competitors. The suppliers could potentially have more business and be closer partners with the competitors than with Volvo Group, and therefore not want to be transparent to Volvo Group. It is similar to what Fawcett & Magnan (2001) state; that is tougher to integrate in practice than in theory. Many suppliers actively do not want to become integrate themselves further with Volvo Group and release internal information. Risks are seen that such an integration could potentially result in reduced bargaining power towards Volvo Group as it can be exploited to the supplier's disadvantage.

A reason why Volvo Group's network approach is structured in this way is to make it easier to manage the complexity as Sedarasan (2013) discusses. The network is most likely structured after what is achievable and not theoretically optimal. Holmen & Pedersen (2003) states that the network horizon or environment of actors can collide and limit how the actors can integrate into the network context. It is a similar case for Volvo Group for how they have chosen to strategize and create beneficial synergies in their network. Today, actors are shared with competitors which limits how Volvo Group can further integrate themselves but still create synergies. The synergies might be limited compared to what Dubios et al (2004); Gadde (2004) describes as the "optimal" network strategy. However, Volvo Group's business network is not designed in this way by "chance". Volvo Group has spent a large amount of time to structure its network. To create routines and standards on how they interact and connect with actors in their network-surroundings. The routines have been created based on their understanding and previous experience within their network. It might not be the best solution for the supplier, carrier, or Volvo Group compared to theory, however, it creates a solid business network.

Fawcett & Magnan (2001); Ketchen & Hult (2007) states that it often exists competition between SC's and competition can be positive as it contributes to development and innovation. A competitive landscape requires the ability to change what is currently best practice. If the SC members would be heavily integrated with Volvo Group, the ability to change would be reduced. On the other hand, integration can contribute to improved operational performance. For this reason, a middle ground is needed to be achieved, a mix between integration and the ability to change due to the competitive landscape. The SCCT would be a good middle-ground for how to develop the integration in the SC without "true" integration. The SCCT would result in a need to share more data and collaborate further than previously. However, in this case, the SCCT change is currently driven by Volvo Group who instructs the business network and the actors what is required. The creation is today not a collaborative approach. Therefore, Volvo Group needs to keep in mind to design the SCCT solution of what is beneficial for other parties to create incentives for them to contribute to the development.

With the SCCT, Volvo Group is centralizing the information flow in the SC and increase the amount of information shared between members. However, the project does not create major changes in the insight into the actor's internal processes nor work structure. The actors are integrated and connected on a "shallow level". This "shallow level" of connection with a SCCT will create benefits for Volvo Group and share synergies with the whole network. The SCCT would be utilized by suppliers, carriers, and cross-docks without large up-front investments because it is created by Volvo Group. The only thing that the actors of the SC need is to follow the work instructions. The SCCT needs to be designed to make things easier for each actor and therefore, work as an incentive for the actors to use it and contribute.

The chosen SCCT tactical strategy is a feasible objective for Volvo Group when considering the current network of sub-supplier-, supplier-, carrier-, and cross-dock- relationships. This is not completely in line with what Fawcett & Magnan (2001) states about "true" SC integration, the authors state it is to be able to have insights about the SC members and use that to strengthen the SC. This question is relevant for the creation of the SCCT-project, however, due to reasons mentioned above such integration is not deemed to be feasible in three years. Therefore, the tactical strategy is limited to a couple of features feasible to create in the current network context. However, OneNetwork (2020) states the long-term goal of a SCCT is to implement the solution throughout the SC (including high tier sub-suppliers not included in the current solution). Volvo Group needs to ask themselves the question of what the long-term objective is for the SCCT. For a SCCT to be extended throughout the SC and include additional features will require further integration than the current relationship and network position allows. This aligns with Gadde (2004); Fawcett & Magnan (2001); Ford et al (2002) who describes SC integration as the foundation for the success of a business network. This master thesis had a significantly shorter time perspective for the SCCT-strategy; however, it will be a relevant question for Volvo Group to ask themselves when moving forward.

This question is relevant for the creation of the SCCT-project, but due to reasons mentioned above such integration is deemed not to be feasible in the given scope, three years. Therefore, the tactical strategy is limited to a couple of features feasible in the current given network context. However, OneNetwork (2020) states the long-term goal of a SCCT is to implement the solution throughout the SC (also with the higher tier sub-suppliers that are not included in the current suggested solution). The foundation for such a long-term goal seems to be missing due to the current network position. Thereby the pre-requirement "organizational willingness" for a SCCT (McInter (2014) needs to be emphasized, as this becomes crucial if the network position shall be reconsidered to enable further SCCT developments. total integration and autonomous decision making. Volvo Group needs to ask themselves the question of what the long-term objective is for the SCCT. For a SCCT to be extended throughout the SC and include features required more integration, the current relationships and network position will need to be reconsidered. This aligns with Gadde (2004); Fawcett & Magnan (2001); Ford et al (2002) who describes SC integration as the foundation for the success of a business network. This master thesis has a significantly shorter time perspective for the SCCT-strategy; however, it will be a relevant question for Volvo Group to ask themselves when moving forward.

9.2 Change Management in Volvo Group

Chopra et al (2013) state that the success factors for the implementation of IT-systems are about taking incremental steps to create how the IT system should be used to support decision-making. Todnem (2005) continuous that change management is a constant process and should also be done incrementally and proactive, however, a lot of companies tend to work reactively to the change. A large challenge for Volvo Group is change management and how change is discussed on an aggregated and target level in the organization. Volvo Group describes that companies as large as Volvo Group tend to have a slow information flow between the different departments. The SCCT is a massive change project for several departments, where the departments will in the future potentially work in new ways.

Today, several departments have raised a concern that they do not know the objective of the SCCT-project and how it will affect their work-life. Chopra et al (2013); Todnem (2005) mentions this as a key success factor for the organization to succeed with a large change project. Therefore, it will be important for Volvo Group to address this situation for the SCCT and how they communicate information about the project. Chopra et al (2013) mention the IT-system "should address the company's key success factors" and how can the SCCT include the success factors without integrating the different departments in the creation-process?

Van Der Meer (2006) continuous that the actor needs to make the employees feel connected and aligned with the business objective of the project. Success comes from within the organization and the creation of collaborative strength according to Van Der Meer (2006); Chorpra et al (2013); Todnem (2005). The collaborative strength and common objective with the SCCT are not observed across departments at Volvo Group. It is a pre-requirement for the long-term success of the SCCT-project. It may seem easy and simple to communicate and get the departments onboard on the objective of the project. However, according to Todnem (2005), 70% of change management projects fail. For a large scale-project as the SCCT it will be of utter importance for Volvo Group to create a clear communication and inclusion strategy for the SCCT. If they do not manage to get the different departments on board with the project it will more likely take more time to create and perhaps miss valuable business information unique for each department.

9.3 Risks with capturing & integration of data

The SCCT will increase the need to capture data of higher quality, however, the pinnacle point for the success of the SCCT-strategy is to integrate data better in Volvo Group's systems. Chopra et al (2013) describe a large risk when integrating information into a system is that it's treated as a "one-stop and shop" alternative (everything is done at once). In Volvo Group's case, it would mean that the SCCT is thought of to be created from a waterfall perspective. Something that Deloitte (2019), BearingPoint (2020), and OneNetwork (2020) all state is not a good or viable implementation plan. Volvo Group will need to create the SCCT and integrate the system in incremental steps and as a continuous process open for adaptation. An important step will be for Volvo Group to think about how they choose to integrate and utilize the captured data to create the intended SCCT features. It may sound simple, however, to integrate and connect the different data-points and systems are one of the toughest challenges for the success of the SCCT. It is a crucial success factor and foundation for the development of all SCCT-features and will be time-consuming and gritty.

As mentioned previously, the data that the presented SCCT strategy will need is already captured in Volvo Group's SC. The initial stage for the SCCT-project becomes to set a method for how to untangle the data from the different silos and departments. Thereafter, how to integrate and use the data from the different departments to create a holistic view over certain functions. As mentioned in section 5.1 there is today several different processes between sub-companies and which standard the sub-company use. Therefore, if the SCCT should be used across all (truck) sub-companies in Volvo Group there will be a need to map the different standards and processes across the companies. Process-variations was a large challenge described by Volvo Group, where there exists a variation across processes. The SCCT-project needs to be designed either around the different processes or create a standard approach to what is integrated and how the users will utilize the SCCT. In summary, a large part of the initial work will be to sort out the different processes and how to integrate the data to work towards the wanted features.

10 Conclusions

In this section, the conclusion of this master thesis is presented.

10.1 Aim and answer to the Research Questions

The aim with this master's thesis was to develop a three-year tactical strategy for Volvo Group's Supply Chain Control Tower. The tactical strategy strive towards to maximize the business outcome and reduce the management of SC complexity for Volvo Group.

Due to a lack of academic research within the field of SCCT's, an analytical framework was developed and applied to Volvo Group's inbound SC context to fulfill the aim of this master thesis. The framework is analytically generalizable and can be applied to other companies who wish to create a SCCT-tactical strategy.

RQ1: What are the current key challenges related to supply chain complexity for Volvo Group's inbound SC?

The current complexity challenges can be found in table 8. The challenges are summarized into four different themes presented in section 5.2.1; namely Data-, Process-, Culture- and External. The challenges related to data were the largest, which included the collection and integration of data from multiple SC actors.

The size of Volvo Group creates complexity challenges across the inbound SC. The challenges are often related to the structure of Volvo Group and how the sub-companies are working in separate silos with their unique processes, trapped data, and culture. The structure of Volvo Group is designed to make it manageable, however, it also results in several observed challenges. The structure and culture create shackles and make it hard for employees to break their silos and access information from other parts of the company. Furthermore, an interesting finding is that no complexity challenges was identified at the sub-suppliers, which we argue highlight the lack of involvements Volvo Group has with them.

RQ2: How can a tactical strategy be designed for a Supply Chain Control Tower to maximize the business outcome?

This thesis suggests Volvo Group's SCCT strategy to include includes nine features presented in section 7. These nine features are suggested to be prioritized and categorized into three tactical steps described in section 8. The three tactical steps are:

(i) The first tactical step ("digitization step") addresses the improvement of current processes to handle deviations in the inbound SC. The improvement focuses on the current ways to collect and integrate data and use more digital capabilities to reduce unnecessary manual tasks. The data can be used to transfer previous manual processes into digital processes, thereby digitizing the processes. (Feature 1,2 & 4)

(ii) The second tactical step ("digitalization step") are combining the features from the first tactical step. The combinations generate new capabilities and create synergies among, creating additional features to transform the business operations. Thereby digitalizing how the need for business decisions are identified. (Feature 5,6 & 7)

(iii) The last tactical step ("decision-support") addressed how alternative cost and performance statistics should be used to analyze various alternatives in the decision-making process. Thereby the capability of a more fact-based decision making is enabled. This tactical strategy designed to fit the Volvo Group context of what is deemed to be feasible, it is however important to note **that** this implementation is challenging but not unimaginable to achieve within three years. (Feature 3, 8 & 9)

10.2 Managerial recommendations

Other factors than the tactical strategy itself are crucial for the success of the implementation of a SCCT. These factors are discussed in section 9. Volvo Group needs to be aware of their network position and align its position to the SCCT objectives to achieve the best outcome. The SCCT is built on securing and sharing data from/to actors in the network to create the intended features to improve the SC, which is why the network position is important as it influences what data can be collected and integrated. Also, Volvo Group will need to work internally with change management and how the SCCT will change internal operations and processes. There are always risks with large IT-projects and if a plan on how to handle change management is not conducted, the tactical strategy can fail. To succeed with large scale IT-projects there is a need to work in incremental steps and to work continuously to improve.

In summary, there are factors that play a vital role in the success of Volvo Group's SCCT. It does not only come down to the technical aspect of the tactical strategy. If done properly, Volvo Group can succeed with the creation of its SCCT and reduce several of the previously mentioned complexity challenges. The SCCT will also improve the SC operations performance and therefore create a higher business outcome for Volvo Group's **inbounone d** SC.

11 References

Baraldi, E., Brennan, R., Harrison, D., Tunisini, A., & Zolkiewski, J. (2007). Strategic thinking and the IMP approach: A comparative analysis. Industrial Marketing Management, 36(7), 879-894.

Bearingpoint. (2020). A digital twin of your supply chain for more transparancy and greater potential. Retrieved 2020-04-06 from https://www.bearingpoint.com/en/our-expertise/innovations/digital-supply-chain-management/log360-digital-supply-chain-management/

Bell, E., Bryman, A., & Harley, B. (2015). Business research methods. Oxford university press.
Bloomberg, J. (2018). Digitization, digitalization, and digital transformation: confuse them at your peril. Forbes. Retrieved on August, 28, 2019.

Bozarth C. C., Warsing D. P., Flynn B. B., Flynn E. J. (2008). The impact of supply chain complexity on manufacturing plant performance. Journal of Operations Management 27 (2009) 78–93'

Bradley, E. H., Curry, L. A., & Devers, K. J. (2007). Qualitative data analysis for health services research: developing taxonomy, themes, and theory. Health services research, 42(4), 1758-1772.

Campion, M. A., Palmer, D. K., & Campion, J. E. (1997). A review of structure in the selection interview. Personnel psychology, 50(3), 655-702.

Casti, J. (1979), Connectivity, Complexity, and Catastrophe in Large-Scale Systems, International Series on Applied Systems Analysis, John Wiley & Sons, Chichester

Chopra, S., Meindl, P., & Kalra, D. V. (2013). Supply chain management: strategy, planning, and operation (Vol. 232). Boston, MA: Pearson.

Collingridge, D. S., & Gantt, E. E. (2008). The quality of qualitative research. American journal of medical quality, 23(5), 389-395.

Cosgrove, E. (2019, June 3). "How P&G created a 'ready for anything' supply chian3. Retrieved from https://www.supplychaindive.com/news/pg-ready-for-anything-supply-chain-disaster-response/555945/

de Casterlé, B. D., Gastmans, C., Bryon, E., & Denier, Y. (2012). QUAGOL: A guide for qualitative data analysis. International journal of nursing studies, 49(3), 360-371.

Deloitte. (2019). Supply Chain Control Tower - The information link for Operations across the liver Enterprise. Retrieved 2020-04-06 from https://www2.deloitte.com/content/dam/Deloitte/de/Documents/operations/10-19-supply-chain-control-tower.pdf

Denzin, N. K. (2009). The elephant in the living room: Or extending the conversation about the politics of evidence. Qualitative research, 9(2), 139-160.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. *Journal of business research*, *55*(7), 553-560.

Dubois, A., Hulthén, K., & Pedersen, A. C. (2004). Supply chains and interdependence: a theoretical analysis. Journal of Purchasing and Supply management, 10(1), 3-9.

Fawcett, S. E., & Magnan, G. M. (2002). The rhetoric and reality of supply chain integration. International Journal of Physical Distribution & Logistics Management.

Filiz Isik (April 26th 2011). Complexity in Supply Chains: A New Approachto Quantitative Measurement of the Supply-Chain-Complexity, Supply Chain Management, Pengzhong Li, IntechOpen, DOI: 10.5772/15005

Fisher, M., L., (1997). What is the right supply chain for your product. Harvard Business Review, 75, 105-116.

Ford, D., Berthon, P., Brown, S., Gadde, L-E., Håkansson, H., Naudé, P., Ritter, T. And Snehota, I. (2002). The Business Marketing Course, John Wiley & Sons, p. 30- 37, p.40-44, p. 48.

Håkansson, H., & Snehota, I. (2006). No business is an island: The network concept of business strategy. Scandinavian journal of management, 22(3), 256-270.

Holmen, E., & Pedersen, A. C. (2003). Strategizing through analyzing and influencing the network horizon. Industrial Marketing Management, 32(5), 409-418.

Ivanov, D., Tsipoulanidis, A., & Schönberger, J. (2017). Global supply chain and operations management. A Decision-Oriented Introduction to the Creation of Value.

Johnson, G., Whittington, R., Scholes, K., (2011). Exporing Strategy. Pearson Education M.U.A.

Ketchen Jr, D. J., & Hult, G. T. M. (2007). Bridging organization theory and supply chain management: The case of best value supply chains. Journal of operations management, 25(2), 573-580.

Lambert, D. M. & Cooper M. C. (2000). Issues in Supply Chain Management. Industrial Marketing Management29, 65–83

Lars-Erik Gadde (2004) Activity Coordination and Resource Combining in Distribution Networks - Implications for Relationship Involvement and the Relationship Atmosphere, Journal of Marketing Management, 20:1-2, 157-184, DOI: 10.1362/026725704773041168

Leech, N. L., & Onwuegbuzie, A. J. (2008). Qualitative data analysis: A compendium of techniques and a framework for selection for school psychology research and beyond. School Psychology Quarterly, 23(4), 587.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. Journal of Business logistics, 22(2), 1-25.

OneNetwork. (2020). Supply Chain Control Tower - From real-time visibility to automation and machine learning. Retrieved 2020-04-06 from https://www.onenetwork.com/supply-chain-management-solutions/supply-chain-control-towers/

Porter M., (1996). What is Strategy? Harvard Business Review 74(6) 61–78.

PostNord. (2019). E-handeln I norden, halvårsrapport 2019. Retrieved form https://www.postnord.se/vara-losningar/e-handel/e-handelsrapporter/e-handeln-i-norden

Ş. Y. Balaman, (2019). Decision-Making for Biomass-based production Chains

Saint McInter, J. (2016). Supply chain visibility: From theory to practice. Routledge.

Serdarasan, S. (2013). A review of supply chain complexity drivers. Computers & Industrial Engineering, 66(3), 533-540.

Shou-Wen J., Ying T., Yang-Hua G. (2013). Study on Supply Chain Information Control Tower System. Information Technology Journal 12 (24).

Stock, G. N., Greis, N. P., & Kasarda, J. D. (2000). Enterprise logistics and supply chain structure: the role of fit. Journal of operations management, 18(5), 531-547.

Supply-Chain Council. (2012). Supply Chain Operations Reference Model 11.0. Retrieved from www.supply-chain.org

Todnem By, R. (2005). Organisational change management: A critical review. Journal of change management, 5(4), 369-380.

Trzuskawska-Grzesińska A. (2017). Control Towers in Supply Chain Management - past and future. Journal of Economics and Management Vol. 27 (1) 2017

Van Der Meer, S., O'Sullivan, D., & Pfeiffer, T. (2006). Large Scale Management of Distributed Systems. Volvo Group. (2017). Volvo Operations Concept Version 2.0

Wallace, M., & Sheldon, N. (2015). Business research ethics: Participant observer perspectives. Journal of Business Ethics, 128(2), 267-277.

Wan, X & Disney S. M. (2015). The bullwhip effect: progress, trends and directions. European journal of operational research 250 (2016) 691-701.

Appendix I

In this section the complexity challenges collected from the interviews are presented with use of examples. The (X number) marks where on table 8 they are located.

Complexity Challenges related to Volvo Group

(6) Capture data:

Bill of materials, warehouse data or similar activities are not reported correctly, creating errors within the business systems on what operational data that exists for Volvo Group. Resulting in a false estimation of the real need of demand for the inbound flow.

(2) Data Integration:

Volvo Group is a large global company. With a lot of different data systems that are not properly integrated in general.

Examples:

When optimizing transport processes, data from different system needs to be collected from various parts of the system to an excel sheet. Data scrubbing is done manually before being inserted to the system again.

When comparing carriers, extensive manual labor is required to find the best option when evaluating carrier options. Data exists but it is not easily accessed in a integrated fashion.

Forecasting is today mostly done through excel and optimization of process, warehouses, transport and various other capacities.

There are also examples that are not regarding Volvo Group's own integrated systems, but that cross-docks are outsourced and do not share the same input and output signals. Resulting in that Volvo Group has access to the data but can't integrate it in a standardized way. Something that has been a problem for Volvo Group when interacting with both suppliers, carriers as well, however hopefully the OIC will help improve this.

(14) Interrupt decisions, reactive problem solving

It is difficult to see the long-term cost effect of various decision in the SC. Therefore, Volvo Group has a more reactive instead of proactive approach to keeping down direct costs. A need for systems that can help support decisions not only based on history but also better forecasts of how everything is connected.

(3) Change management difficulties

Large organizations such as Volvo Group has always had a problem dealing with rapid change. Volvo Group is a large organization with many different levels of management and departments. For the information to reach the individual level at Volvo Group there is a need to communicate the long-term plans better. People can have a hard time adjusting to large changes and they need a reason to understand why those specific changes are happening. Change does not only come from a top perspective but should also come from the bottom of the organization, in form of a grassroots movement.

(8) Culture, Volvo Group has always been working in Silos

Volvo Group has historically been very processed focused and has not had a history of working cross-functionally across departments. Today, Volvo Group is not collaborating or working well across boarders where department are measured from an internal perspective. Resulting in that different departments does not understand the connection between each other and that they can together generate positive SC synergies.

(7) Regional process variations, across different geographical zones

Volvo Group consists of several "sub" companies globally where all countries have different ways of conducting business. It is hard to create a global culture with "one" shared view on business processes. Changes that change "how you have done business historically" is hard to implement.

(15) System loopholes

Systems at Volvo Group are not perfect, therefore there are ways of entering information to the system which is not correct. Resulting in wrong system information and additional work for re-work.

(19) Culture at Volvo to acceptance of deficiency

There is a culture at Volvo Group to accept deficiencies in their processes. Certain people are not working towards a 100% satisfaction goal, however just towards the target that Volvo Group has set as an objective. Therefore, creating a situation where the employees might not want to figure out the root-problem behind the actual made mistakes.

Complexity Challenges related to Suppliers

(12) Supplier Capacity Constraints

There is a reoccurring problem that suppliers are not able to deliver to what they have promised. The suppliers can also fail to communicate the lack of goods to Volvo and therefore it creates a information gap in Volvo's SC. There are multiple reasons to why this occurs, the supplier can have problems in their own SC or simply hit a capacity constraint and cannot keep up with the volumes. A common problem for companies operating in a business environment with large economic volatility.

Complexity Challenges related to Carriers

(5) Capture data, lack of transportation data

A problem for Volvo Group is that carriers are not sure of what exact goods are on their trucks and even if they did, they do not want to share that information to Volvo Group. There is today no clause in the contract that states that carriers should collect this type of data. The only data that carriers are contracted to report is point-of-deliver and point-of-arrival (or deviations) which are all done manually.

There for it exists no data for bottlenecks or where deviations actually occur in the transportation flow. Resulting in that Volvo Group does not have the data to evaluate the risks of different routes from more than a cost perspective.

(11) Carriers, deviations reports.

Carriers forget or simply do not report deviations in time to Volvo Group resulting in that the ETA is not correct. The carriers are contracted to deviate report in a standardized process. However, drivers sometimes have language difficulties and there might be a lack of communication within the outsourced carrier companies. To further state, deviation reports are mostly done correctly however, if not it is still a challenge.

Complexity Challenges related to Cross-docks

(10) Data integration, lack of cross-dock integration.

Volvo Group has a challenge to forecast the material flow to the cross-docks and to see when they are operationally constrained. In order to do this Volvo Group needs to coordinate data from various systems and create their own forecasts through Excel.

As mentioned previously, cross-docks also have different systems. Resulting in that there is no standard for the data that is being collected from the different cross-docks which could be one factor why the data is even harder to coordinate.

(16) Cross-docking process variations

Similar to previous paragraph, Volvo Group is today outsourcing their cross-docks to different contracted companies. The outsourced parts have different business routines for how they send out their goods, resulting in a lack of standard in process alignment.

Complexity Challenges related to External Factors

(1) External factors

It is hard to anticipate things that does not happen "logically", there are unforeseen disturbances that happens a couple of time each year, this year (2020) it is the Covid-19 virus, it could be strikes, yellow wests, IT-problem that all makes it hard to optimize the inbound SC.

There also external factors e.g. traffic, weather, accidents that constantly affect the SC and today Volvo Group is working very reactive to those type of changes through deviation reporting from all different actors in the network.

When crisis do erupt it is a challenge to have a plan for how to handle that specific situation. Actors in the network cannot be prepared for everything because it results in a reduced efficiency of your day-to-day operations, however, it becomes a trade-off.

Complexity Challenges related to the Supply Chain:

(4) Capture data – Supply Chain

There is a general challenge to capture data for different actors in the SC. There might not be a consensus for which actor should capture the specific data and why they should do it, resulting in a lack of data for other actors in the network.

(9) Integrated data, generally

In similar fashion as the paragraph above, there is a large challenge to integrate the data that has been captured in the whole SC. There is a deviation in the SC about how transparent different actors want to be with their collected data. There is a challenge to create win-win situations for all actors to share and create a common business value from the willingness to integrate.

The next question becomes, who owns the master data throughout the SC? There are no standards for how data is handled within SC's and actors want to gain economic compensation or some business value from actively sharing their own internal business data. This also results in that there is no standard for how data is being collected across the SC and that there is no standard for how different data variables matches towards each other in the network.

(13) Deviations reports – lack of deviations reports generally

There is a general lack of detection of deviations in the SC. Information about deviations communicates slowly across the network and can be postponed in order for actors to "try" to solve the problem themselves before it might reach and affect other actors.

(17) Capture data, sustainable data

There is a general problem how to capture data regarding sustainability. How do you measure sustainability in concrete way to get a better understanding about how it affects the whole SC. Data to measure various alternative are key factors for taking sustainable long-term decisions for Volvo Group.

(18) Capture data, financial data

Financial data is not being used in decision making to find the best financial option in various solutions. By collecting and integrating financial data for decision makers when evaluate various solutions, more cost awareness is possible.

Appendix II

Interview Structure I

"We are two master thesis students from Chalmers University of Technology within their Supply Chain Management Program. Our supervisors at Volvo Group are Björn Nilsson and Federico Garofalo. Our master thesis is relating to the subject's digitalization and strategy within supply chains. More specifically our task is to present a short-term roadmap for an "Operational Control Tower" could be implemented in the most efficient way. Furthermore, we will investigate whether Volvo Group has the right pre-requirements and the feasibility of the roadmap. It was recommended by XX to contact you as you might have valuable insights of the projects related to "Supply Chain Control Towers" currently being worked upon.

Our purpose of this interview is to get a deeper understanding of what digitalization projects that has been executed, currently is developed and is planned to be developed.

Would it be okay with you to record this interview?"

Interview object

- Describe your position within Volvo Group.
- Could you tell us about your professional background within Volvo Group?
- What project are you currently working on?
- Would you say you have good knowledge about projects related to SCCT?

SCCT today - *finished projects*

- Do you know when Volvo Group actively started to work towards an SCCT?
- Which projects are finished that can relate to SCCT?
- What was the objective with these projects for Volvo Group?
- Is the projects finished and currently within the operations?

SCCT today – Projects being worked upon

- Which projects are Volvo Group currently working with that are related to SCCT?
- What is the objective with these projects for Volvo Group?
- When are they planned to be finished?

SCCT future – planned projects

- Which projects are Volvo Group planning to perform that are related to SCCT?
- What is the objective with these projects for Volvo Group?
- When are they planned to start?
- When are they planned to be finished?

Interview Structure II

"We are two master thesis students for Björn Nilsson and Federico Garofalo from Chalmers University of Technology, studying the master program within Supply Chain Management. Our master thesis is regarding digitalization and strategy within Supply Chains. We have got an assignment to describe a road-map for how a Supply Chain Control Tower could be planned. Providing if Volvo Group has the right technical foundation and whether or not it is reasonable. We have received your name from XX as an interesting object to talk to regarding Volvo Group Inbound Supply Chain.

This interview is conducted to get a deeper understanding of the supply chain and its challenges. The goal of this interview is not to get any additional information about the Supply Chain Control Tower but to map the current challenges of Volvo Group's Inbound Supply Chain".

Would it be okay with you to record this interview?"

Introduction:

- Describe your position within Volvo Group?
- Can you tell us about your background within Volvo Group?

Description of Volvo Group's Inbound Supply Chain:

- Do you consider yourself to have a good understanding of Volvo Group's Inbound Supply Chain?
- Could you briefly describe Volvo Group's Inbound Supply Chain?
- Which parts are most important, critical?

Challenges within the inbound Supply Chain:

- Which are the biggest challenges for Volvo Group's Inbound Supply Chain?
    - (Which are of greatest importance of the ones stated)

The next steps are iterative for each challenge.

- What do you think should be needed to solve that specific challenge?

Internal factors:

- Do you think there is a drive from within the employees of Volvo to solve that challenge?
- Do you think that Volvo Group has the organizational capacity to change?

Technical factors:

- If data is needed: will the quality of the data need be able to be collected?
    - E.g. correct data, real-time data, and useful data.
- If data is needed: What is needed for all the decision makers to access the data?
- If technical demands: Does the technical capabilities exist to solve the challenge?

External factors:

- What is needed from partners and suppliers?

"The next step is conducted to get an understanding of the value, cost and the difficulty to work with the challenges from your perspective. All challenges will be cross-referenced against other interviews and theory that we have mapped".

- Value of the solution to the challenges on a scale 0-10, where 0 is no value and 10 is of high value.
    - (With of high value we mean that it would practically revolutionize how Volvo Group works today).
- Cost to solve the challenges on a scale 0-10, where 0 is that it is practically free and 10 is impossible financially.
- Difficulty to implement the solution on a scale 0-10, where 0 is that it can be implemented without any challenges and 10 is impossible.

"The interview is iterated one each new challenge that is presented".