Roosa Perälä

Implementing Supply Chain Visibility in Complex Manufacturing

Qualitative Case Study

School of Technology and Innovations
Industrial Systems Analytics
Industrial Engineering and Management

Vaasa 2026

UNIVERSITY OF VAASA
School of Technology and Innovations
Author: Roosa Perälä
Title of the thesis: Implementing Supply Chain Visibility in Complex Manufacturing: Qualitative Case Study
Degree: Master of Science in Technology
Degree Programme: Industrial Engineering and Management, Industrial Systems Analytics
Supervisor: Jyri Naarmala
Year: 2026 **Pages:** 96

ABSTRACT:
This master's thesis has been conducted as part of the Master's degree in Industrial Systems Analytics at the University of Vaasa. The thesis examines the implementation of supply chain visibility in a complex manufacturing environment. Supply chain visibility is considered important for operational planning, disruption management, decision making and customer service. Many companies still face difficulties in implementing visibility effectively in practice. The need for empirical and qualitative research on supply chain visibility barriers has also been identified in previous research.

The objective is to identify the factors that hinder effective supply chain visibility implementation in a complex make-to-order manufacturing environment. Also, the thesis examines organisational practices that support visibility and the requirements from suppliers and customers that enable effective supply chain visibility. The main concepts of the study are supply chain, supply chain management and supply chain visibility. The theoretical part of the thesis discusses definitions of supply chain visibility, as well as its enablers, barriers, requirements and outcomes.

The study has been conducted as a qualitative empirical single case study. The case company is a large global manufacturing organisation, and the study focuses on one case unit operating in a complex make-to-order manufacturing environment. The empirical data has been collected through semi-structured interviews. The interviewees were selected from functions directly connected to supply chain visibility, including logistics, manufacturing, procurement and customer care. Managerial and employee perspectives were included. The interviews were transcribed automatically, and the data was analysed manually using open coding and axial coding.

The results show that the supply chain visibility barriers are connected to several technical, process related organisational and interorganisational factors. The main barriers identified in the case company include limited visibility toward suppliers, deviations from standard processes, lack of a clear process for communicating changes, limitations in the ERP system and data architecture, fragmented information outside the ERP system, time pressure, acceptance of inaccurate data and limited management involvement in visibility development.

The study also identifies several practices that support supply chain visibility in the case company. These include clear responsibilities for data correction, active communication between functions, trust, cooperation, resources and a positive attitude toward improvement. The findings show that active communication shouldn't replace reliable systems, standardised processes and systematic data management.

KEYWORDS: Supply chain, supply chain management, supply chain visibility, visibility barriers, complex manufacturing, case study, qualitative research.

VAASAN YLIOPISTO
School of Technology and Innovations
Tekijä: Roosa Perälä
Tutkielman nimi: Implementing Supply Chain Visibility in Complex Manufacturing: Qualitative Case Study
Tutkinto: Tuotantotalouden tekniikan maisteri
Koulutusohjelma: Industrial Engineering and Management, Industrial Systems Analytics
Työn ohjaaja: Jyri Naarmala
Valmistumisvuosi: 2026 **Sivumäärä:** 96

TIIVISTELMÄ:
Tämä diplomityö on tehty osana Vaasan yliopiston Industrial Systems Analytics -maisteriohjelmaa. Työssä tarkastellaan toimitusketjun näkyvyyden käyttöönottoa monimutkaisessa valmistusympäristössä. Toimitusketjun näkyvyyttä pidetään tärkeänä operatiivisen suunnittelun, häiriöiden hallinnan, päätöksenteon ja asiakaspalvelun kannalta. Monet yritykset kohtaavat edelleen vaikeuksia näkyvyyden tehokkaassa käyttöönotossa. Aiemmassa tutkimuksessa on myös tunnistettu tarve empiiriselle ja laadulliselle tutkimukselle toimitusketjun näkyvyyden esteistä.

Tavoitteena on tunnistaa tekijöitä, jotka estävät tehokasta toimitusketjun näkyvyyden käyttöönottoa monimutkaisessa tilausohjautuvassa valmistusympäristössä. Lisäksi työssä tarkastellaan organisatorisia käytäntöjä, jotka tukevat näkyvyyttä, sekä toimittajiin ja asiakkaisiin liittyviä vaatimuksia, jotka mahdollistavat tehokkaan toimitusketjun näkyvyyden. Tutkimuksen keskeisiä käsitteitä ovat toimitusketju, toimitusketjun hallinta ja toimitusketjun näkyvyys. Työn teoreettisessa osassa käsitellään toimitusketjun näkyvyyden määritelmiä sekä sen mahdollistajia, esteitä, vaatimuksia ja vaikutuksia.

Tutkimus on toteutettu laadullisena empiirisenä yksittäistapaustutkimuksena. Kohdeyritys on suuri globaali valmistusorganisaatio, ja tutkimus keskittyy yhteen kohdeyksikköön, joka toimii monimutkaisessa tilausohjautuvassa valmistusympäristössä. Empiirinen aineisto on kerätty puolistrukturoidulla haastattelulla. Haastateltavat valittiin toiminnoista, jotka liittyvät suoraan toimitusketjun näkyvyyteen, kuten logistiikasta, valmistuksesta, hankinnasta ja asiakaspalvelusta. Mukana oli esihenkilöiden ja työntekijöiden näkökulmia. Haastattelut litteroitiin automaattisesti, ja aineisto analysoitiin manuaalisesti avoimen ja aksiaalisen koodauksen avulla.

Tulokset osoittavat, että toimitusketjun näkyvyyden esteet liittyvät useisiin teknisiin, prosesseihin liittyviin, organisatorisiin ja organisaatioiden välisiin tekijöihin. Kohdeyrityksessä tunnistettuja keskeisiä esteitä ovat rajallinen näkyvyys toimittajiin, poikkeamat standardiprosesseista, selkeän muutosten viestintäprosessin puute, ERP-järjestelmän ja data-arkkitehtuurin rajoitteet, ERP-järjestelmän ulkopuolelle hajautunut tieto, aikapaine, virheellisen tiedon hyväksyminen sekä rajallinen johdon osallistuminen näkyvyyden kehittämiseen.

Tutkimuksessa tunnistetaan myös useita käytäntöjä, jotka tukevat toimitusketjun näkyvyyttä kohdeyrityksessä. Näitä ovat selkeät vastuut datasta, aktiivinen viestintä funktioiden välillä, luottamus, yhteistyö, resurssit sekä myönteisyys kehittämiseen. Aktiivinen viestintä ei saisi korvata luotettavia järjestelmiä, standardoituja prosesseja ja systemaattista datanhallintaa.

AVAINSANAT: Toimitusketju, toimitusketjun hallinta, toimitusketjun näkyvyys, näkyvyyden esteet, monimutkainen valmistus, tapaustutkimus, laadullinen tutkimus.

Contents

1 Introduction 7

1.1 Background 7

1.2 Research Gap and Problem Statement 10

1.3 Research Question and Objectives 11

1.4 Scope and Limitations of the Study 12

1.5 Structure of the Thesis 13

2 Literature review 14

2.1 Supply Chain 14

2.2 Supply Chain Management 21

2.3 Supply Chain Visibility 22

2.4 Factors, Barriers, Enablers and Requirements of SCV 26

2.4.1 Enablers of SCV 30

2.4.2 Barriers of SCV 32

2.4.3 Requirements for effective SCV 39

2.4.4 Outcomes of effective SCV 42

3 Method 45

4 Results 52

4.1 SCV Barriers in case company 52

4.2 Organisational Practices Supporting SCV in the case company 58

4.3 The need for visibility 60

4.4 Comparison of Empirical Findings with Literature 61

4.5 Theoretical Contributions 65

4.6 Quality and ethics of the study 70

5 Conclusions 73

5.1 Summary of Key Findings 73

5.2 Answer to research Question 74

5.3 Recommendations for the Case Company 76

5.4 Suggestions for Future Research 79

References 82

Appendices 89

Appendix 1. Research Permit Application 89

Appendix 2. Cover Letter 90

Appendix 3. Interview Framework in English 91

Appendix 4. Interview Framework in Finnish 94

Figures

Figure 1. The Value Chain. 16

Figure 2. A framework of the supply chain. 17

Figure 3. The Supply Chain. 18

Figure 4. Supply Chain. 19

Figure 5. The Supply Chain. 20

Figure 6. A view of Supply Chain Visibility from a manufacturer's perspective. 25

Figure 7. Basic types of designs for case studies. 47

Figure 8. Overview of coding process: Open, Axial and Selective Coding. 51

Tables

Table 1. Summary of data elements, factors and benefits of SCV identified in literature. 27

Table 2. Data elements that are important for supply chain visibility. 29

Table 3. Enablers for supply chain visibility. 31

Table 4. Main barriers to supply chain visibility. 36

Table 5. Kinds of barriers. 37

Table 6. Barriers and challenges for SCV. 38

Table 7. Factors acting as challenges to supply chain visibility. 39

Table 8. Business requirements. 40

Table 9. Technological solutions. 41

Table 10. Antecedents for SCV. 42

Table 11. Drivers for supply chain visibility. 43

Table 12. Drivers of SCV. 44

Table 13. SCV barriers in the case company, identified from the interview data. 56

Table 14. Relevant Situations for Different Research Methods. 80

1 Introduction

This research is conducted as part of the Master's degree in Industrial Systems Analytics at the University of Vaasa and forms part of the requirements for the degree of Master of Science in Technology. This master's thesis explores the implementation of supply chain visibility in a complex manufacturing environment through a qualitative case study. The purpose of the study is to increase understanding of the factors that hinder the implementation of supply chain visibility, the practices that support it and the wider requirements needed to improve visibility in practice. By combining previous research with empirical evidence from the case company, the thesis aims to contribute to academic discussion and to the practical development of supply chain visibility.

This introductory chapter presents the overall context and purpose of the thesis. The subchapter 1.1 outlines the background of supply chain visibility and its relevance in complex manufacturing environments. The subchapter 1.2 then identifies the research gap and problem statement. The subchapter 1.3 research question and objectives of the study. After that, the subchapter 1.4. addresses the scope and limitations of the research. The last subchapter 1.5. concludes by presenting the structure of the thesis. The planning, structure and implementation of this master's thesis follow the guidelines outlined in the University of Vaasa's Quick Guide for Industrial Management Thesis Works (Helo et al., 2019).

1.1 Background

In recent years, the concept of supply chain visibility (SCV) has been gaining the attention of practitioners and researchers, and the discourse is taking place in operations management and journals of supply chain management (Kalaiarasan, Olhager et al., 2022, p. 1). According to Swink et al. (2024, p. 1–2) managerial surveys and articles cite many important drivers of this growing interest. First, increasing customer demand for faster, more reliable and more informed deliveries (the "Amazon effect") pressures firms to

improve operational planning, coordination and track-and-trace capabilities. Second, recent volatility in demand and supply underlines the need to rapidly identify and mitigate potential disruptions. Third, increasing societal and regulatory demands for greater supply chain transparency of environmental and social metrics encourage SCV investments. Executives currently prioritise SCV as an important capability (Swink et al., 2024, p. 1–2).

Supply chain visibility can be understood as the extent to which supply chain actors have access to information that gives support their operations and decision making across the supply chain (Somapa et al., 2018, p. 308). The concept extends beyond simple information sharing, as the exchanged information must also be relevant, accurate, timely, trustworthy and usable to assist effective supply chain management (Caridi et al., 2014, p. 2). According to Kalaiarasan, Olhager et al., (2022, p. 4) the supply chain visibility is shaped by people, processes and technology, including trust, collaboration, information sharing, integration and connectivity.

The supply chain visibility can improve capabilities like agility, planning, decision-making and risk management, while also enhancing performance in terms of cost, customer service, profitability, quality and sustainability (Kalaiarasan, Olhager et al., 2022, p. 5). Swink et al. (2024, p. 19) show that supply chain visibility can support capabilities and outcomes, including analytics, coordination, resilience, responsiveness and improved operational and financial performance. Supply chain visibility has gained increasing attention because limited visibility exposes firms to disruptions, weakens resilience and reduces their ability to achieve sustainable and competitive performance in complex supply networks (Kalaiarasan, Olhager et al., 2022, p. 1).

This study is about the barriers of SCV. Some overarching barriers have been identified in recent publications already. According to Kalaiarasan, Olhager et al. (2022, p. 5), the supply chain visibility is hindered by budget constraints, poor information quality, reluctance to share sensitive information, lack of standardised systems, limited resources and supply chain complexity. Somapa et al. (2018, p. 335) argue that organisational factors,

like silos and lack of common metrics also hinder the successful implementation and development of supply chain visibility. But there is still limited research of the area, and many researchers have made a note of this.

According to Kalaiarasan, Olhager et al. (2022 p. 7–9), research on supply chain visibility remains fragmented and existing conceptual models cover a limited number of factors, which shows the need for a comprehensive understanding of the barriers, drivers and effects of supply chain visibility. An important finding of the review is that most existing studies assess supply chain visibility mainly from automation and informational perspectives, while the the use of information for improvement remains under studied (Somapa et al., 2018, p. 334–335). The authors also bring up that the relationship between supply chain visibility and business performance remains insufficiently demonstrated, because existing research lacks clear metrics that connect visibility effectiveness to changes in business processes and performance outcomes (Somapa et al., 2018, p. 335).

This thesis focuses on implementing supply chain visibility in a complex manufacturing context. The case company is a large global manufacturing organisation with long global supply chains, complex manufacturing environments and make-to-order (MTO) production. In make to order environments orders are customer specific and are triggered by customer demand rather than produced for stock. This creates high dependency on timely and accurate information. Material availability and supplier reliability directly affect production schedules and production outcomes influence delivery reliability and customer promises. Despite there being available researched methods and best practices related to SCV, the case company continues to struggle to implement visibility effectively. The case context offers a relevant setting to investigate how SCV implementation challenges come up in practice and what organisational conditions support or hinder effective visibility. It is not good to draw overarching conclusions, produce generalisable theory from a single case study, so the aim for this research paper is to be the one of many case studies about the topic to produce a solid pool of data and to produce valuable theory.

1.2 Research Gap and Problem Statement

This research is important from organisational and academic perspectives. From an organisational perspective, the case company continues to face difficulties in effectively implementing supply chain visibility practices, despite the availability of extensive research, established methods and best practices related to supply chain visibility. This makes the topic practically relevant, as identifying the barriers to supply chain visibility so the company can improve its supply chain operations.

From an academic perspective, the study addresses a clear research gap. Although supply chain visibility has been widely recognised as important for supply chain performance, empirical research on the supply chain visibility remains limited (Delgado et al., 2025, p. 1; Kauppila et al., 2020, p. 84). Delgado et al. (2025, p. 1) specially spotlight the limited research on visibility barriers in supply chains and call for future studies to investigate these barriers empirically. Similarly, Kauppila et al. (2020, p. 84) note that transparency remains a major managerial challenge, even though information is increasingly available and easier to share, while scientific research on the topic still lacks a strong empirical basis. Agrawal et al. (2024, p. 2939) further show the need for more empirical studies on supply chain visibility, like case studies, action research and best practice research, to deepen understanding of the relevant factors and their relationships. Also, prior literature has mainly focused on the technological aspects of supply chain visibility, while managerial perspectives, like how organisations identify, prioritise and address visibility related factors in practice, have received less attention (Agrawal et al., 2022, p. 2939). This study contributes to the existing literature by providing empirical insight into the barriers that hinder supply chain visibility in practice and by examining the issue from a managerial perspective.

The expected outcomes of this study are the identification of key supply chain visibility barriers, the development of practical recommendations for the case company and the

proposal of future research directions, including the extension of the study into a multiple case study. So, the research problem is that although supply chain visibility is considered important organisations still face difficulties in implementing it effectively and empirical knowledge of the barriers to supply chain visibility remains limited.

Keywords of this paper are Supply Chain, Supply Chain Management and Supply Chain Visibility. A supply chain (SC) refers to a network of organisations connected through upstream and downstream activities that create value as products and services for the final customer through different processes and activities (Christopher, 2011, p. 4). Supply chain management (SCM) includes the planning and management of sourcing, procurement, conversion and logistics activities across this network (Blanchard, 2010, p. 20). Supply chain visibility, in turn, means access to high quality information of all factors involved with demand and supply, where information quality depends on accuracy, timeliness, completeness and usability (Williams et al., 2013, p. 545).

1.3 Research Question and Objectives

As Eisenhardt (1989, p. 536) says that a clearly defined research focus is essential in case study research, because without it the researcher may become overwhelmed by the volume of data. For this reason, the research question and objectives play a central role in guiding the study, delimiting its scope and ensuring that data collection remains systematic and relevant. This thesis investigates SCV implementation barriers and supporting practices in a complex MTO manufacturing environment through an empirical case study.

Research Question:

> *What factors hinder effective supply chain visibility implementation in a complex make to order manufacturing environment?*

Research Objectives:

1. What barriers prevent effective visibility implementation?

2. What organisational practices support visibility?

3. What requirements from suppliers and customers make possible effective supply chain visibility?

1.4 Scope and Limitations of the Study

This study has some limitations that should be considered when interpreting the findings. The research is limited to a single case company, which means the results can be strongly context specific and may not be directly generalisable to other organisations or industries (Yin, 2018, p. 58). This case approach allows an in depth understanding of supply chain visibility implementation challenges within this context (Yin, 2018, p. 58).

Secondly, the geographical scope of the study is restricted to the Finnish operations of the case company. Although the company operates globally, the study focuses only on one unit located in Finland. As a result, the findings may not fully capture differences in practices, structures or visibility related challenges across other regions or business units.

Third, the methodological scope is limited to qualitative research methods. The study relies on qualitative data to gain a deeper understanding of organisational, operational and cultural factors affecting supply chain visibility implementation (Yin, 2018, p. 179). While this supports rich analysis, it also means that the study does not provide numerical or statistical measurements (Yin, 2018, p. 179).

1.5 Structure of the Thesis

The structure of this thesis follows the general thesis structure recommended in the Quick Guide for Industrial Management Thesis Works by the University of Vaasa (Helo et al., 2019, p. 8). The guide recommends a five-part structure consisting of introduction, literature review, method, results and conclusions, because this structure supports writing and reading the thesis clearly.

This thesis is divided into five main chapters. The first chapter introduces the research topic. It presents the background of the study, the research gap and problem statement, the research question and objectives and the scope and limitations of the study. The chapter ends by describing the structure of the thesis. The second chapter presents the literature review. It explains the concepts of supply chain and supply chain management. After this, the chapter focuses on supply chain visibility. It discusses the factors, barriers, enablers and requirements related to SCV. The chapter also presents possible outcomes of effective supply chain visibility. The third chapter describes the research method. It explains the qualitative single case study design, the data collection process and the interview method. It also describes how the interview data was analysed and how confidentiality, research quality and ethical issues were considered. The fourth chapter presents the results and discussion of the empirical study. It introduces the SCV barriers identified in the case company and the organisational practices that support SCV. The chapter then compares the empirical findings with the literature. It also presents the theoretical contributions and quality and ethical considerations of the study. The fifth chapter concludes the thesis. It summarises the key findings, answers the research question, gives recommendations for the case company and presents suggestions for future research. The thesis ends with the reference list and appendices. The appendices include the research permit application, the cover letter and the interview frameworks in English and Finnish.

2 Literature review

This chapter presents the theoretical background of the thesis. The purpose of the literature review is to define the main concepts of the study and to build a foundation for the empirical analysis. The chapter discusses the concepts of supply chain and supply chain management. After this, the focus moves to supply chain visibility, including its definitions, factors, enablers, barriers, requirements and outcomes.

The literature review was used to guide the study, but it was not used to limit the empirical analysis too narrowly. Vaughan (1992, p. 195) gives an important warning about theory: “The paradox of theory is that at the same time it tells us where to look, it can keep us from seeing.” This idea was considered in the research process. The first version of the interview framework was prepared before the literature review was fully completed, so that the interviews would not be based only on existing theoretical categories. After the literature review, the interview framework was developed further to make sure that the questions were connected to the research gap, research objectives and earlier SCV literature.

This approach helped balance theory and empirical openness. The literature provided important concepts and direction for the study, but the interview data was still allowed to bring forward practical issues that were not fully expected in advance. This was important because the aim of the thesis was to understand how supply chain visibility barriers appear in a real organisational context.

2.1 Supply Chain

According to Hsuan et al. (2015, p. 15) the supply chain can be understood as a coordinated and cooperative network that competes with other networks, rather than them being just a set of isolated firms. A supply chain can also be defined as a set of three or more entities directly involved in upstream and downstream flows of products, services,

finances and information from a source to a customer (Mentzer et al., 2001, p. 4). This usually includes suppliers, processors, distributors and users and supporting parts and organisations that provide transport, communication and other services (Hsuan et al., 2015, p. 15).

Carter et al. (2015, p. 89) argue that supply chain research needs a clearer theory of what the supply chain itself is, including its structure, boundaries and network nature. This supports the idea that a supply chain should not be seen only as a simple linear chain of companies, but as a connected system with many actors and relationships.

Handfield and Nichols' (2002, p. 8) definition describes the supply chain as including all organisations and activities involved in the flow and transformation of goods from raw materials to the end user, together with the related information and monetary flows. Mentzer's (2001, p. 2) definition is that it is a set of at least three companies connected through upstream and downstream flows of products, services, finances and information from source to customer. It also distinguishes between different levels of scope. One being a basic supply chain made up of a key company, an immediate supplier and an immediate customer. Another being an extended supply chain that also includes the supplier's supplier and the customer's customer. Third level being an ultimate supply chain that covers all firms from the initial supplier to the ultimate customer (Mentzer, 2001, p. 2). Also, Hsuan et al. (2015, p. 23) note that a supply chain may share members with other supply chains, which shows that supply chains should not be seen as fully separate/closed systems.

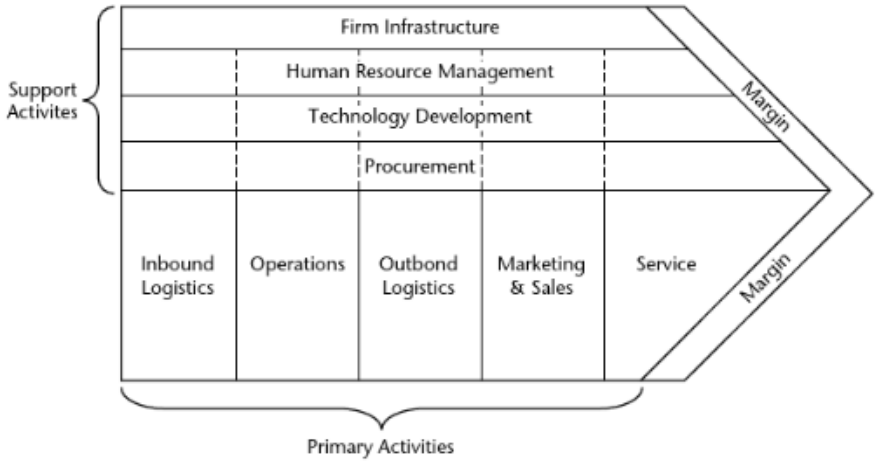

Figure 1. The Value Chain. (Porter, 1989, p. 37).

Hsuan et al. (2015, p. 16) connect the concept of the supply chain to Porter's (1989, p. 37) value chain framework as shown in Figure 1. In this framework, value is created through a series of primary activities, which are inbound logistics, operations, outbound logistics, marketing and sales and service. These are supported by procurement, technology development, human resource management and firm infrastructure, including management and planning functions like finance, accounting and quality management. According to Hsuan et al. (2015, p. 16) the value chain is an important foundation for understanding the supply chain, because it highlights the importance of operations as a counterpart to strategy. It shows how differences in activities that create value can become sources of competitive advantage.

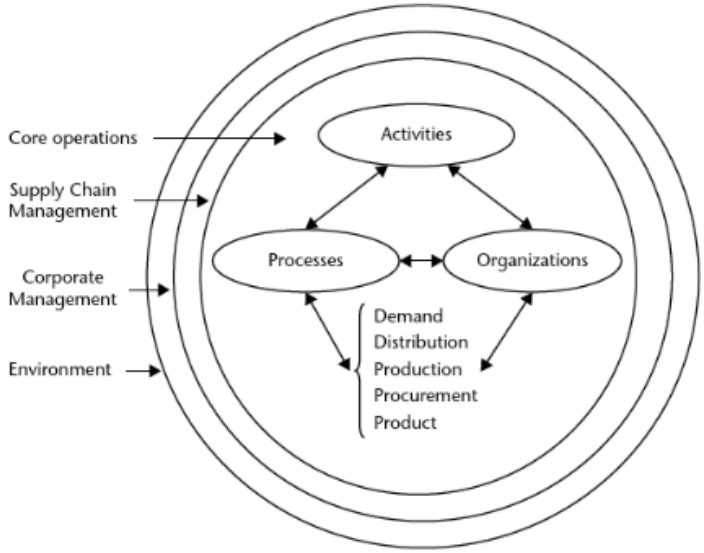

Figure 2. A framework of the supply chain (Hsuan et al., 2015, p. 24).

Hsuan et al. (2015, p. 23–24) explain the supply chain to consists of three major components, that are activities, organisations, and processes and operations as seen in Figure 2. Activities mean what is being done in the chain. Organisations mean the actors involved Processes and operations mean how these activities are carried out and linked together. The authors describe these combined elements as a long-linked technology, meaning that they form an extended chain of connected activities and decisions. This framework is useful, because it shows that the supply chain is not just firms linked in sequence but also about how activities and processes are arranged across those firms.

Wieland argues that supply chains should be understood as fluid and interwoven systems rather than as static and isolated structures, which supports viewing supply chains as dynamic systems (Wieland, 2021, p. 58). At the same time Hsuan et al. (2015, p. 25) notes that the supply chain should be seen as both a network and a system. It is a network because products and information move through many connected organisational units. It is systemic because activities organisations and processes are connected and affect one another. This means that the supply chain should be understood as more than a simple chain of separate things. It is a connected structure where different parts influence each another.

Hsuan et al. (2015, p. 27) also describe the supply chain through five operating processes: demand management, distribution, production, procurement and returns. Demand management includes market activities like forecasting, customer service, customer order processing, market coordination and sales support. Distribution links production to customers. It also affects logistics, because the market requires good service and efficient deliveries. Production adds value to product flow and affects inventory, transport and delivery time. Procurement links manufacturing stages together and widens production through external purchasing. Returns complete the loop by remanufacturing products and components and making possible to reuse or recycling of resources in production. These processes show that the supply chain involves forward movement toward the customer as well as reverse activities that influence value creation, transport and waste.

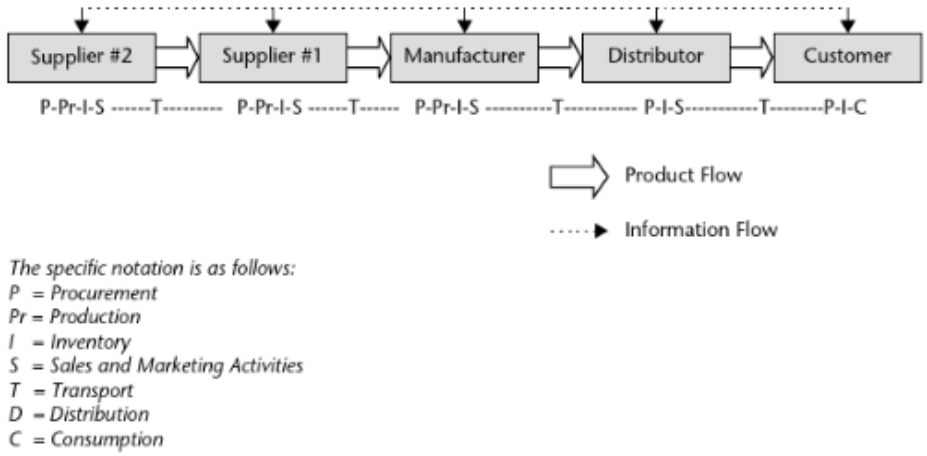

Figure 3. The Supply Chain. (Hsuan et al., 2015, p. 43).

The figure 3 on activity deployment in the supply chain illustrates that the roles of supply chain members are not fixed in the same way in every case. Procurement, production, inventory, sales, marketing, transport, distribution and consumption can be shared differently across suppliers, manufacturers, distributors and customers. For example, upstream parts of the supply chain could carry out inventory or sales activities with procurement and downstream actors can take responsibility for transport or distribution.

This goes with the view that the supply chain should be analysed only as a sequence of firms but also as a set of activities. Its structure depends on how these activities are divided and coordinated among participating organisations.

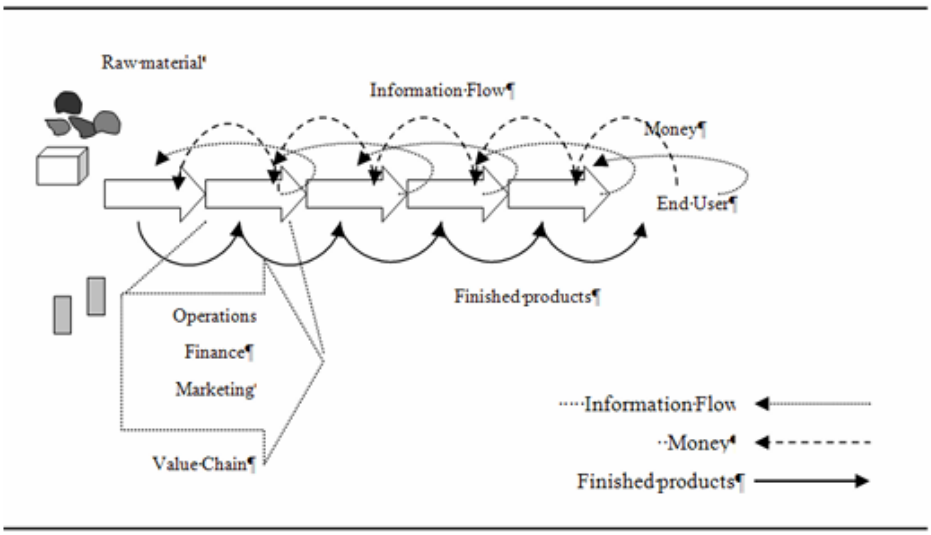

Figure 4. Supply Chain (New and Payne, 1995).

Figure 4 from New and Payne shows that the supply chain is not limited to the forward movement of products. The model also includes reverse and overlapping flows of information and money. It also links these flows to value creating functions like operations, finance and marketing. This shows that the supply chain is not just a straight path for physical goods. It includes many connected flows and activities that depend on each other.

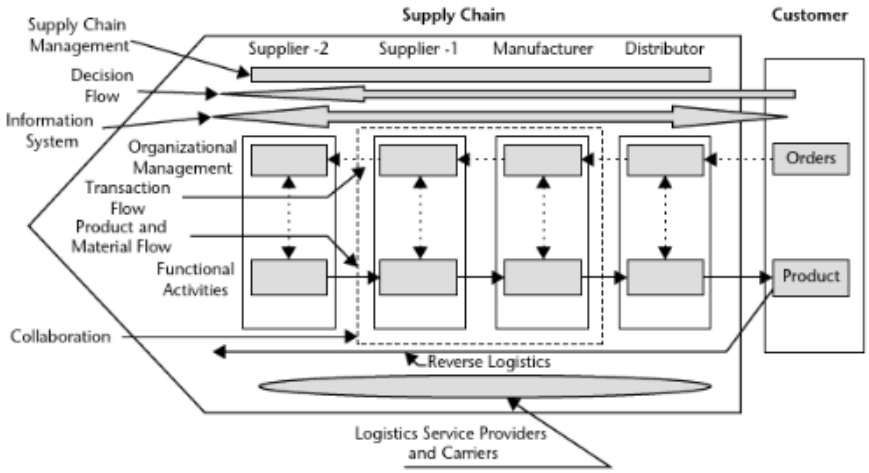

Figure 5. The Supply Chain. (Hsuan et al., 2015, p. 33).

The figure 5 of the global supply chain presented by Hsuan et al. (2015, p. 33) includes suppliers, manufacturers, distributors, customers, logistics and carriers and it highlights many layers of interaction. The figure shows decision flow, information systems, collaboration organisational management and reverse logistics. So, the supply chain seems to be a layered structure where coordination and control extend beyond direct buyer-supplier relationships. It also reflects the idea by Hsuan et al. (2015, p. 15–16) that supply chains cross organisational and geographical boundaries and require integration of operational and managerial processes.

Asgari et al. (2016, p. 353) note that supply chains have become increasingly global and complex, which creates a need for organisations to better design, manage and improve them. This supports the view that supply chains include several connected layers of actors, flows and decisions, rather than only direct buyer-supplier relationships.

So, a supply chain is more than the movement of goods from suppliers to customers. It also includes information, money, decisions, co-operation and returns. The different parts of the supply chain are connected and changes in one part can affect the others. This is why visibility is important. To manage the supply chain well, companies need to know what is happening across these connected activities and organisations. The next chapter focuses on supply chain visibility.

2.2 Supply Chain Management

Supply chain management is a relatively new concept and according to Hsuan et al. (2015, p. 18) and there is still no generally accepted single definition for it. Frequently cited definition presented by Cooper et al. (1997, p. 2), who describe supply chain management as the integration of business processes from the end user back to the original suppliers to provide products, services and information that create value for customers and other stakeholders. The main idea in it is integration. Integration here refers to coordination across functional areas and across legal corporate boundaries. This means that supply chain management is not just managing one company's own activities. It is also about coordinating work between many organisations.

Hsuan et al. (2015, p. 19) also refer to Bechtel and Jayaram (1997, p. 17), who identify five different schools of thought in supply chain management. The concept of SCM has developed through many perspectives over time. One way of thinking is the functional chain awareness that sees a chain of functional activities as the basis for material flow. The second is logistics and it shows the connections between functional areas, especially in logistics and transportation. The third is about information and gives importance to two-way information flow between parts of the chain. The fourth focuses on the integration of processes in the supply chain with customer satisfaction as the main thing. The fifth presents a future oriented view where SCM is demand driven and seamless pipeline where relationships and transactions are seen in the same importance. These different viewpoints show that supply chain management can be understood in different ways depending on what aspects of the chain are given priority.

Hsuan et al. (2015, p. 20) also note that the supply chain is open to different interpretations depending on the management perspective also. Logistics, manufacturing and corporate strategy each have different views of what the supply chain consists of. This suggests that supply chain management cannot be understood from just one angle. Its

meaning depends on whether attention is directed primarily to the movement of goods, the organisation of production or the broader strategic role of the SC.

One example of the manufacturing perspective described by Hsuan et al. (2015, p. 21). There the supply chain is interpreted as an extended factory in which successive suppliers feed the final stage of production and after products go to distribution. This perspective is not concerned with links to areas outside production and focuses more strongly on internal production. Direct involvement with transport and distribution is limited, except where these are implied by the production flow. According to Hsuan et al. (2015, p. 21), the main strength of the manufacturing perspective is that it provides a clear focus, since the transformation of materials into delivered products is seen as the core of operations.

Zhao et al. (2011, p. 17) add that internal integration is an important foundation for external integration with suppliers and customers. They argue that companies must first develop internal integration capabilities through system, data and process integration before meaningful external integration can be achieved. This supports the idea that SCM is not only about coordinating separate companies, but also about making sure that the company's own internal functions, systems and processes work together. This is relevant for this thesis because supply chain visibility also requires both internal visibility inside the case unit and external visibility toward suppliers and customers.

2.3 Supply Chain Visibility

In recent years, SCV has received more and more attention from researchers and practitioners. This growing interest comes from visibility being seen as an important part of supply chain performance and that many companies still struggle with insufficient practical implementation despite its known importance. The global disruptions experienced during recent years have further brought up the vulnerabilities created by low visibility. (Kalaiarasan, Agrawal et al., 2022, p. 1)

Francis (2008, p. 180) notes that the term supply chain visibility is sometimes used inconsistently, which makes it important to define clearly what kind of visibility is being studied in a specific context. Definition from Barratt and Oke (2007, p. 4) was selected because it is one of the most established sources on SCV, and a commonly used and widely cited from a well know peer reviewed publication Journal of Operations Management. It describes SCV as the extent to which actors in a supply chain can access or share information that they consider important for their operations and beneficial for all involved parties (Barratt and Oke, 2007, p. 4). Very similarly Somapa et al. (2018, p. 308) describe SCV as the extent to which supply chain actors have access to timely and accurate information that is useful for their operations. They connect SCV also to the visibility of demand and inventory information across the supply chain. This information-oriented view shows that effective SCM depends also on if the relevant information is available and can be used in a coordinated way. Definition from Somapa et al. (2018, p. 308) was selected because it reviews earlier SCV literature and explains SCV through characteristics including information access, timeliness, accuracy and usefulness. It is published in The International Journal of Logistics Management, which uses a double-anonymous peer review process and is also well cited.

Kalaiarasan, Agrawal et al. (2022) offer a a peer reviewed journal article published in the International Journal of Production Research, a well-established journal in production, manufacturing, logistics and operations management. The source is especially relevant for this thesis because it focuses directly on supply chain in a real industrial context. According to Kalaiarasan, Agrawal et al. (2022, p. 1) some important characteristics of SCV include information accessibility, accuracy, timeliness, completeness and the use of information for operational and strategic purposes. SCV is not simply about collecting more data. Its value depends on whether information is available in a form that helps management and decision-making process in the supply chain.

Kalaiarasan, Olhager et al. (2022) source is a recent peer reviewed systematic literature review published in the International Journal of Production Economics, and it reviews 47 empirical SCV studies and develops the ABCDE framework. Kalaiarasan, Olhager et al. (2022, p. 1) note that visibility upstream toward suppliers and downstream toward customers is often limited and that beyond the visible range firms may be forced to accept conditions they cannot properly monitor or influence. Lower tier suppliers are especially difficult to see and may not even be known to key firms. Companies face disruptions to material supply, deliveries, productivity and revenue and low visibility also weakens their ability to achieve supply chain resilience. For this reason, the management of disruptions across global suppliers, operations and markets has increased attention to SCV to support sustainable and competitive business performance. (Kalaiarasan, Olhager et al., 2022, p. 1)

Agrawal et al. (2022) provides a recent peer reviewed study in a that was published in International Journal of Production Research. It is relevant because it provides expert based managerial insight into the key factors, enablers and challenges of SCV. Agrawal et al. (2022, p. 2927) state that visibility in the extended supply chain requires visibility of internal and external operations. They further explain that SCV requires management efforts to gather information about upstream operations, downstream operations and internal business processes throughout the supply chain. This means that visibility must cover more than one part of the chain and cannot be limited to direct suppliers or direct customers. (Agrawal et al., 2022, p. 2927–2978).

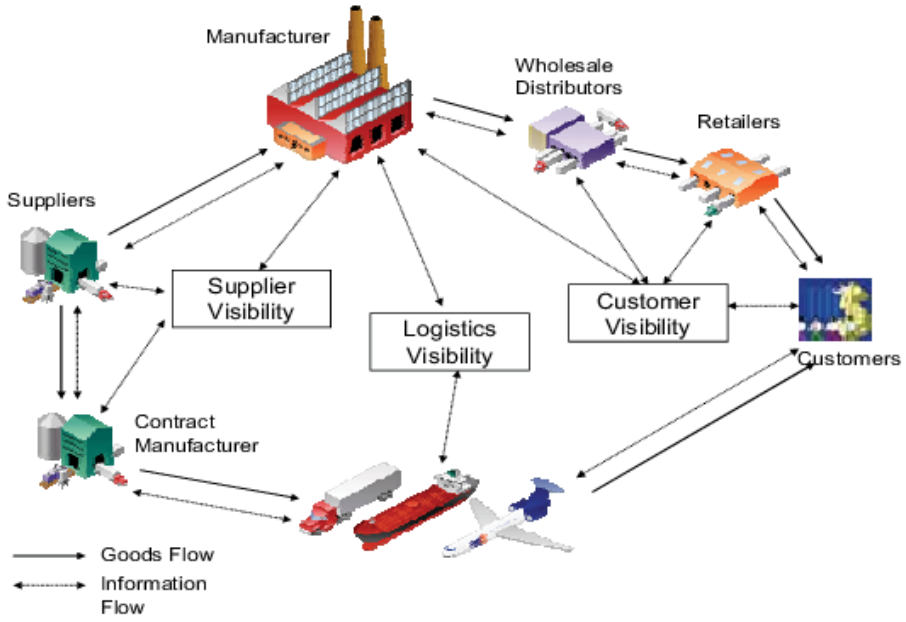

Figure 6. A view of Supply Chain Visibility from a manufacturer's perspective (Zhang et al., 2008)

Figure 6 from Zhang et al. (2008) visual model explains supply chain visibility from a manufacturer's perspective, which fits the context of this thesis. It shows this wider understanding by presenting visibility from a manufacturer's perspective. It shows that visibility extends toward suppliers, contract manufacturers, logistics activities, wholesale distributors, retailers and customers. The model also distinguishes between goods flow and information flow, which underlines that supply chain visibility concerns more than physical movement alone. From this perspective, SCV involves visibility toward suppliers, logistics and customers at the same time, showing that the manufacturer must coordinate information across many directions rather than just along a one linear chain.

The practical relevance of SCV is tied to performance improvement. Caridi et al. (2014, p. 2) state that the main purpose of supply chain visibility is to improve company performance, including decision-making. They also note that many initiatives and programmes, like Quick Response, Efficient Consumer Response, Vendor Managed Inventory and Continuous Replenishment, have incorporated the idea that visibility contributes to better performance. As a result, the benefits of visibility are often assessed through

improvements in supply chain performance, including cost, quality, service level, flexibility and time. (Caridi et al., 2014, p. 2)

2.4 Factors, Barriers, Enablers and Requirements of SCV

Previous literature has many different categories for factors, barriers, enablers and requirements for SCV. Agrawal et al. (2022, p. 2930) provide a useful foundation for this understanding by summarising the main data elements, influencing factors and benefits of SCV identified in the literature.

The table 1 by Agrawal et al. (2022, p. 2930) summarises the main data elements, influencing factors and benefits of supply chain visibility identified in the literature. The table shows that SCV is a a concept with many parts rather than just a technological solution. It includes internal visibilities, like information on inventories, products and processes and external visibility, like dynamic status information, status predictions and product information across upstream and downstream supply chain actors. The table also identifies the main factors that affect SCV. These are divided into managerial and technological factors. Managerial factors include culture, information sharing, interorganisational collaboration and trust. This shows that visibility depends strongly on how willing organisations and individuals are to share information and cooperate across functional and organisational boundaries. Technological factors include collaborative systems, compatibility of IT infrastructures, connectivity, information quality, RFID, blockchain and additive manufacturing. These factors show that suitable digital tools and integrated systems are also required to collect, process and share information effectively. The table presents the benefits of SCV. These benefits are grouped into analytics capability and operational performance. From an analytics perspective, SCV supports agility, decision-making, planning capabilities and risk management. From an operational perspective, it can improve customer service, profitability, responsiveness and sustainability. The table demonstrates that SCV creates value by improving the availability of supply chain information

and the organisation's ability to use that information for operational and strategic decision-making.

Table 1. Summary of data elements, factors and benefits of SCV identified in literature. (Agraval et al, 2022, p. 2930).

Data elements of SCV	Factors affecting SCV	Benefits of SCV
Internal visibility: - Inventories - Products - Processes *External visibility*: - Dynamic status - Prediction of status - Products in the upstream and downstream supply chain	*Managerial*: - Culture - Information sharing - Inter-organisational collaboration - Trust *Technological*: - Additive manufacturing - Blockchain - Collaborative systems - Compatibility of IT infrastructures - Connectivity - Information quality - RFID	*Analytics capability*: - Agility - Decision-making - Planning capabilities - Risk management *Operational performance*: - Customer service - Profitability - Responsiveness - Sustainability (economic, social, environment)

Kembro and Selviaridis (2015, p. 455) also show that information sharing in extended supply chains depends on the type and strength of interdependence between supply chain actors. Their study found that companies often focus information sharing on closer dyadic relationships, while information sharing across several supply chain tiers can become more difficult. This is relevant for SCV because visibility depends not only on what information exists, but also on how easily it can be shared across supplier, internal and customer relationships.

Kembro et al. (2017, p. 77) say that information sharing across multiple supply chain tiers depends on several antecedents, including information utilisation, technology utilisation, power structures, culture, business processes and legal factors. This supports the view that SCV is affected by both technical and organisational conditions. It also shows why visibility becomes more difficult when information must be shared across several actors and tiers in the supply chain.

Agrawal et al.'s (2022, p. 2932) table 2 on data elements that are important for supply chain visibility further specifies what types of information are needed to create this shared operational picture. The table divides the data elements into customer-related, internal and supplier factors. Customer factors include deliveries, deviations orders, demand, forecasts and country of origin. These elements are important because they make possible the organisation to follow customer orders, identify deviations, understand demand and communicate accurate information to customers. Among these, deliveries and deviations receive particularly high importance ratings, which suggests that the ability to monitor delivery status and respond quickly to disruptions is central to SCV. The same table also highlights internal factors, like inventory levels, capacity, lead times, production plans and safety stocks. These are essential because internal visibility determines whether the organisation can understand what is available, what can be produced, when production can take place and whether stock levels are sufficient. Inventory levels and capacity receive the highest importance ratings in this category, indicating that visibility into available stock and production capability is especially for planning and delivery reliability. Supplier-related factors, like purchasing plans, supplier capabilities, supply status, supplier location and track information, complete the end-to-end view. These supplier-related data elements are necessary because internal planning is dependent on upstream availability and supplier performance. Table demonstrates that SCV depends on the integration of demand, internal and supply side information.

Table 2. Data elements that are important for supply chain visibility (Agraval et al, 2022, p. 2932).

Categories and factors	Description / Examples	Mean (Std. dev.) *
Customer-related factors		
Deliveries	Follow the status of the delivery process, to inform customers if needed	6.10 (0.83)
Deviations	Prompt information about deviations and their nature	6.05 (1.12)
Orders	Content and status of customer orders	6.00 (1.00)
Demand	Customer demand, incl. end customer demand	5.86 (0.73)
Forecasts	Sales forecasts	5.67 (1.11)
Country of origin	Establish material origin, to communicate to customers	5.14 (1.90)
Internal factors		
Inventory levels	Inventory levels at all locations	6.24 (1.22)
Capacity	Production capacity in all factories	6.10 (1.09)
Lead times	Production and transportation lead times	6.05 (1.07)
Production plans	Sharing internal production plans with suppliers and customers	5.62 (1.07)
Safety stocks	Security levels at stock points	5.29 (1.59)
Supplier-related factors		
Purchasing plans	Share planned purchase quantities with suppliers	5.76 (1.14)
Supplier capabilities	Supplier capacities, technical capabilities, and VMI experience	5.71 (1.38)
Supply	Follow the status of incoming material supply	5.57 (0.98)
Supplier location	Manufacturing and inventory locations for suppliers	5.24 (1.73)
Track and trace	Track and trace goods from the origin	5.24 (1.45)

* Scale: '1' = unimportant, and '7' = extremely important.

However, the information alone is not enough. Hazen et al. argue that data-driven supply chain decisions are only as useful as the quality of the data on which they are based (Hazen et al., 2014, p. 72). The quality and characteristics of information also determine whether visibility is useful in practice. Swink et al. (2022, p. 9) note that research on information sharing has shown the importance of info quality - accuracy, timeliness, completeness and formatting. Later research has expanded this view by considering characteristics like conciseness, reliability, frequency, aggregation level and credibility or trustworthiness. The trustworthiness of information is especially important, because

credible information sharing must be distinguished from “cheap talk”, meaning non-binding and non-verifiable information sharing. This means that SCV requires more than access to data. The information must also be accurate, timely, sufficiently detailed, reliable and presented in a form that helps with decision-making. (Swink et al., 2022, p. 9)

SCV should be understood as an information capability and an organisational capability. It depends on what information is available, how accurate and timely that information is and whether it can be shared and trusted across the supply chain. The literature suggests that visibility is created through relevant data elements, high information quality, functioning systems and organisational practices that support information sharing between internal and external supply chain actors.

2.4.1 Enablers of SCV

This chapter discusses the main enablers of supply chain visibility. Enablers are factors that help companies collect, share and use supply chain information more effectively. They can include technical factors, like data quality and integrated systems and organisational factors - trust, collaboration and top management support for example.

Enablers can also be understood as the opposite side of barriers. A factor can work as an enabler, while the absence of that same factor can become a barrier. For example, good data quality supports SCV, while poor data quality limits it. Similarly, trust supports information sharing, while lack of trust prevents it. Bastas and Liyanage (2021, p. 330) describe an enabler as the opposite of a barrier or as a way to overcome barriers. They also explain that the same factor may be an enabler or a barrier depending on its presence or absence in a specific context.

Agrawal et al.’s (2022, p. 2934) table 3 on enablers for supply chain visibility identifies the organisational and technological conditions. The highest-rated enabler is data quality, including data resolution, accuracy, consistency and timeliness. This is a central finding,

because even advanced systems cannot create meaningful visibility if the data within them is inaccurate, outdated or inconsistent. Information sharing is the second enabler, referring to the willingness to share real time information. This shows that SCV is dependent on organisational behaviour and collaboration between supply chain actors (Agrawal et al., 2022, p. 2934). Management support, trust and interorganisational collaboration are also identified as important enablers. These factors show that visibility requires commitment beyond operational teams. Management must support visibility initiatives, share resources and encourage cross-functional and interorganisational cooperation. Trust is particularly important because companies and partners may be reluctant to share information if they fear misuse, loss of bargaining power or exposure of weaknesses. The table also identifies common supply chain master data, connected or integrated systems and standardisation as enablers. These factors show that SCV requires both social and technical foundations: people must be willing to share information, while systems and data structures must make such sharing possible in a consistent and reliable way. (Agrawal et al., 2022, p. 2934)

Table 3. Enablers for supply chain visibility (Agraval et al., 2022, p. 2934).

Factors	Description / Examples	Mean (Std.dev.)*
Data quality	Data resolution, accuracy, consistency and timeliness	6.38 (0.74)
Information sharing	Willingness to share information, share real-time information	6.29 (0.72)
Top management support	Supply chain and senior management support to establish visibility system	6.19 (0.87)
Trust	High degree of trust	6.10 (1.04)
Inter-organisational collaboration	Collaboration with supply chain partners for long-term and reciprocal relationships	5.86 (0.85)
Common SC master data	Master data setup with strong information and data management capabilities, establish common language	5.62 (1.43)
Connected/integrated systems	System integration and support to create visibility	5.52 (1.25)
Standardisation	Develop system in a standardised way for usage e.g. have a harmonised definition of data fields	5.52 (1.03)

* Scale: '1' = unimportant, and '7' = extremely important.

Supply chain collaboration is also an important enabler of visibility. Cao and Zhang (2011, p. 163) show that supply chain collaboration can improve collaborative advantage and firm performance. From an SCV perspective, this means that visibility is easier to develop when supply chain actors work together, share information and create joint benefits instead of acting only separately.

Digital integration is another important enabler of SCV. Rai et al. (2006, p. 225) show that digitally enabled supply chain integration capabilities can improve firm performance, especially through operational excellence and revenue growth. This supports the view that integrated systems and digital information flows can make supply chain information more available and useful for decision-making.

IT integration can also support flexibility and agility in the supply chain. Swafford et al. (2008, p. 288) show that IT integration helps firms use supply chain flexibility, which can then improve supply chain agility and business performance. This is relevant for SCV because visibility is more useful when information can move quickly between systems, functions and supply chain partners.

The literature shows that SCV enablers are both technical and organisational. Effective visibility requires accurate data, integrated systems and standardised information structures, but also trust, collaboration, information sharing and management support. These enablers form the foundation for understanding which organisational practices support visibility in the case company.

2.4.2 Barriers of SCV

This chapter reviews selected frameworks that describe barriers to supply chain visibility. The purpose is not to list every possible barrier from the literature but to focus on frameworks that are especially useful for this thesis. The selected frameworks give a broad and

practical view of the topic and match the empirical analysis of barriers in the case company.

The framework by Delgado et al. (2025, p. 6–8) was selected because it is one of the more recent studies on supply chain visibility barriers. This is important because the topic is constantly developing. Globalisation, automation, digitalisation, Industry 4.0 technologies and artificial intelligence are changing how companies collect, share and use supply chain information. Newer research is useful when studying current visibility challenges. Delgado et al. also combine findings from several earlier studies into one framework. This makes their framework useful because it brings together many barriers identified in previous research. Delgado et al. group the barriers into larger categories: resource-related barriers, dynamic capabilities-related barriers and strategic or cultural barriers. This second classification is useful because it shows that SCV barriers are not just technical problems. They are also connected to resources organisational capabilities, strategy and culture. The article is published in Sustainability, an MDPI journal. The journal is an international, peer reviewed open access journal and its manuscripts are reviewed by at least two independent experts after editorial checks. The journal is also indexed in major databases, for example Scopus and Web of Science according to MDPI's indexing page.

The framework by Kalaiarasan, Olhager et al. (2022) was selected for similar reasons. It is also relatively recent and is based on a systematic literature review of empirical research on supply chain visibility. Their ABCDE framework combines barriers and challenges, drivers and SCV effects. This makes it useful for this thesis because it places barriers inside a wider SCV context. It also groups barriers into internal, customer-related, supplier-related and supply chain level challenges. This is important for the present study because supply chain visibility is not created by one company alone. It depends on internal functions, suppliers, customers and the wider supply chain network. The article is published in the International Journal of Production Economics, which is an Elsevier academic journal and is peer reviewed and very often cited source.

The study by Agrawal et al. (2024) was selected because it gives a different perspective from the two literature review frameworks. Instead of only listing barriers from earlier studies, Agrawal et al. use a Delphi study with supply chain experts to prioritise managerial perspectives on SCV. This is useful because it shows which visibility factors are considered important by experienced professionals. The numerical impact level categorisation gives an additional way to understand the relative importance of different challenges. The article is published in the International Journal of Production Research, which is a well-established journal in production, manufacturing, operations management and logistics. The article uses a multistage Delphi study with 26 supply chain experts from globally recognised enterprises with manufacturing units worldwide. It is a recent peer reviewed empirical article.

Together, these three frameworks provide a strong basis for analysing SCV barriers in this thesis. Delgado et al. provide a recent and detailed barrier framework, Kalaiarasan, Olhager et al. connect barriers to the broader SCV literature and Agrawal et al. add a managerial and prioritised perspective. Using these frameworks together helps to build a more balanced understanding of SCV barriers before analysing the empirical findings from the case company.

Delgado et al. (2025, p. 6–7) identify several main barriers to supply chain visibility, which are presented in Table 4. Many barriers are related to data and information systems. Lack of data standardisation makes it difficult to collect and compare information from different supply chain actors. Lack of sufficient infra also limits visibility, because companies need suitable digital systems and information sharing tools. Even when data exists, companies may struggle to combine data from different supply chain parts. Too much data can also become a problem, because data overload makes decision-making slower and more difficult. Other barriers are about to costs and technical capabilities. Implementing visibility solutions often requires investments in technologies, system integration and training. This can be expensive and companies may not always clearly see the benefits.

Employees may lack the technical knowledge needed to use new tools effectively. Supply chain visibility also depends strongly on trust and collaboration. Companies may be unwilling to share data because they are concerned about sensitive information, data accuracy or the possible miss use of information. Lack of collaboration between supply chain partners can therefore reduce the quality and amount of shared information. Visibility is affected by supply chain complexity and external conditions. Long distances, many actors, different company sizes, different technology levels and international legal differences can make visibility more difficult. Companies may also lack clear objectives for using visibility technologies, especially when trying to improve sustainability or performance.

Table 4. Main barriers to supply chain visibility (Delgado et al., 2025, p. 6–7).

Barriers	Characterization	Authors
B1-Lack of data standardization.	The lack of data standardization for the implementation of SCV systems.	Agrawal et al. (2024) [1]; Aoulad et al. (2023) [35]; Brookbanks; Parry, (2022) [11].
B2-Lack of adequate infrastructure.	Lack of an information infrastructure. The information infrastructure is an open and shared set capable of covering different types of data from different technology sources.	Knol & Tan (2018) [8]; Xu et al. (2024) [5].
B3-Costs associated with the implementation of AI-IT4.0 technologies.	Cost of technologies and lack of balance between technology costs and business benefits	Finkenstadt & Handfield, (2021) [32]; Knol & Tan, (2018) [8]
B4-Distrust in sharing data.	Trust issues and concerns over data accuracy.	Cao et al. (2022) [12]; Wyciślak & Akhtar, (2024b) [16]
B5-Complexities in the supply chain.	Long distances between parties, budget disparities across SC partners, different levels of technological advancement, and different company sizes.	Goh & Garg (2008) [4]; Hilletofth & Lättilä (2012) [14].
B6-Lack of collaboration.	Lack of collaboration in sharing data with supply chain partners.	Mehrotra, (2010) [9]; Wyciślak & Akhtar, (2024) [16].
B7-Lack of technical knowledge and training for the use of AI-IT4.0.	The lack of technical knowledge and training to work with AI-IT4.0 technologies makes data sharing difficult.	Njualem (2022) [36]; Oliveira & Handfield (2019) [37]; Vilko et al. (2019) [38] Moshood et al. (2021) [39]; Panigrahi et al. (2023) [33]
B8-Data overload.	The data needs to be clear and concise to facilitate decision-making. Excessive data hinders data analysis and information flow.	Kalaiarasan et al. (2022) [3]; Meyer-Larsen et al. (2012) [34]
B9-Lack of ability to combine data across a supply chain.	The data needs to be combined concisely and clearly to facilitate faster decision-making.	Moshood et al. (2021) [39]; Njualem (2022) [36]; Oliveira & Handfield (2019) [37]; Panigrahi et al. (2023) [33]; Vilko et al. (2019) [38].
B10-Lack of uniform and international legal regulation	A clear and objective international standard on visibility helps prevent cybercrimes and addresses cultural challenges and communication barriers.	Lafargue et al. (2022) [6].
B11-Lack of clear objectives for using AI-IT4.0 to generate data related to sustainability practices (environmental, social and economic).	There is a lack of awareness that using AI-IT4.0 for increasing visibility throughout the SC can contribute to improving its sustainability performance.	Wyciślak & Akhtar, (2024) [16]
B12-Disbelief in the benefits of visibility for supply chain performance (environmental, social, and economic).	Limited empirical results that prove the benefits of visibility for sustainability.	(Kalaiarasan et al., 2022) [3].

In table 5 Delgado et al. (2025, p. 8) group the barriers to supply chain visibility into three main categories: resource barriers, dynamic capabilities barriers and strategic or cultural barriers. Resource-related barriers are connected to the resources that companies need in order to implement supply chain visibility. These include data standardisation, adequate infrastructure, implementation costs, technical knowledge and the ability to combine data across the supply chain. Without these resources, visibility systems are difficult to build and use effectively. Dynamic capability-related barriers are connected to the company's ability to adapt, collaborate and manage information in a changing supply chain environment. These barriers include distrust in data sharing, supply chain complexity, lack of collaboration, data overload and the lack of uniform international legal regulation. These issues show that visibility depends on how well companies can

coordinate and respond to changing conditions. Strategic or cultural barriers are about attitudes, objectives and beliefs inside the organisation. These include the lack of clear objectives for using visibility technologies and disbelief in the benefits of visibility for supply chain performance. If a company does not clearly understand why visibility is needed or if managers and employees do not believe in its value, implementation becomes more difficult.

Table 5. Kinds of barriers (Delgado et al., 2025, p. 8).

Kinds of Barriers	Barriers
Resource-related barrier (Saqib & Zhang, 2021) [41]	B1-Lack of data standardization B2-Lack of adequate infrastructure B3-Costs associated with the implementation of AI-IT4.0 B7-Lack of technical knowledge and training for the use of AI-IT4.0 B9-Lack of ability to combine data across a supply chain
Dynamic capabilities-related barrier (Sunmola & Apeji, 2024) [20]	B4-Distrust in sharing data B5-Complexities in the supply chain B6-Lack of collaboration B8-Data overload B10-Lack of uniform and international legal regulation
Strategic or cultural barrier (Suh & Lee, 2018) [42]	B11-Lack of clear objectives for using AI-IT4.0 to generate data related to sustainability practices B12—Disbelief in the benefits of visibility for supply chain performance

Table 6 Kalaiarasan, Olhager et al., (2022, p. 5) table on barriers and challenges for SCV further develops the barrier perspective by classifying challenges into internal, customer, supplier and supply chain categories. Internal barriers include budget constraints and poor data quality. These are important because companies may recognise the need for improved visibility but lack the financial resources, system capability or data discipline required to implement it effectively. Customer-related barriers include reluctance to provide data, while supplier-related barriers include budget constraints, limited visibility beyond first tier suppliers and risk of losing business. These findings show that SCV is limited also by the willingness and capability of external actors to participate in information sharing. At the broader supply chain level, Kalaiarasan, Olhager et al. identify conflict of interest, diverse sources of information, lack of standardisation, lack of skills and knowledge and supply chain complexity as major barriers. These barriers come up in Agrawal et al.'s text. Both studies underline that fragmented information, non-standardised systems and supply chain complexity make it difficult to establish reliable visibility. Also, Kalaiarasan, Olhager et al. highlight skills and knowledge, suggesting that SCV also

requires employees and organisations to have sufficient competence to interpret data, use systems and develop visibility processes.

Table 6. Barriers and challenges for SCV (Kalaiarasan, Olhager et al., 2022, p. 5).

Sub-category	Factor	Source(s)
Internal	Budget constraints	Swift et al. (2019), Ghasemy Yaghin and Goh (2020)
	Poor data quality	Klueber and O'Keefe (2013), De Oliveira and Handfield (2019)
Customers	Reluctance to provide data	Kaipia and Hartiala (2006)
Suppliers	Budget constraints	Klueber and O'Keefe (2013), Yu and Goh (2014)
	Limited to/by first-tier	Caridi et al. (2010), Caridi et al. (2013), Brun et al. (2020)
	Risk of losing business	Jüttner and Maklan (2011)
Supply chain	Conflict of interest	Klueber and O'Keefe (2013), Cho et al. (2017)
	Disparate sources of information	Srinivasan and Swink (2018)
	Lack of standardization	Klueber and O'Keefe (2013)
	Lack of skills and knowledge	De Oliveira and Handfield (2019)
	Supply chain complexity	Kaipia and Hartiala (2006), Caridi et al. (2010), Brandon-Jones et al. (2014), Brun et al. (2020)

The challenges identified in the table 7 by Agraval et al (2022, p. 2935) include lack of standardisation, supply chain complexity, insufficient IT infrastructure, unwillingness to share data, data coming from multiple sources, limited supply chain competence and organisational culture. These factors show that the difficulties implementing SCV are not just technical. They also relate to collaboration, data management, knowledge and the broader organisational environment.

Table 7. Factors acting as challenges to supply chain visibility. (Agraval et al., 2022, p. 2935).

Factors	Description / Examples	Mean (Std.dev.) *	# Indicated as barrier
Standardisation (lack of …)	Lack of standardised tools, systems and technical standards	5.05 (1.18)	3
SC complexity	Global complex supply chains with long lead times, several warehouses, heavy and bulky products, large product portfolio	4.85 (1.23)	1
IT infrastructure (lack of …)	IT systems that are rarely or never created for visualisation	4.75 (1.29)	3
Willingness to share data (lack of …)	SC partners do not want to share information with others with respect to fear of losing information advantage	4.70 (1.84)	4
Data from multiple sources	Data coming from many different IT solutions and in different formats need to be mapped in the right way	4.60 (1.47)	1
SC competence (lack of …)	E.g. Competence to develop methods and IT support to provide to businesses that will maintain and improve supply chains	4.47 (1.17)	1
Organisational culture	Silo thinking, Conflict of interest	4.35 (1.46)	2

* Scale: '1' signifies a factor that is not even considered a challenge, '2' represents a minor challenge, '4' a medium challenge,'6' a major challenge, and '7' is associated with a barrier.

So, the reviewed barriers show that SCV implementation is affected by a combination of technical, organisational and interorganisational factors. The main recurring themes are data quality, standardisation, system capability, collaboration, competence, supply chain complexity and organisational culture. These themes create the basis for analysing how similar barriers appear in the empirical case company.

2.4.3 Requirements for effective SCV

Effective supply chain visibility requires clear business requirements and suitable technological solutions. Kalaiarasan, Agrawal et al. (2022, p. 15) identify many business requirements that visibility systems should support in table 8. The most fundamental requirement is real time monitoring, which enables visibility from the point of loading at suppliers' locations to delivery at logistics centres. This monitoring is important because it allows organisations to follow material flows as they happen, rather than relying just on delayed or manually updated information.

Table 8. Business requirements (Kalaiarasan, Agrawal et al., 2022, p. 15).

Business requirements	Descriptions
Real-time monitoring	Provide real-time visibility from the point of loading at suppliers' locations to delivery at logistics centres
Improve forecasting accuracy	Utilise real-time data to improve forecasting accuracy
Improve planning accuracy	Utilise real-time data to improve planning accuracy
Implement virtual stock	Provide digital tracking of stock levels in transit
Autonomous docking and departure	Utilise real-time visibility to support automatic docking and departure across the supply chain
Automatic localisation	Utilise real-time visibility to support automatic identification and localisation of required operations
Autonomous planning and forecast	Utilise historical and real-time data to support the transition to automatic planning and forecasting
Autonomous storage and capacity management	Utilise real-time visibility to support automatic storage and capacity management

Effective SCV should improve forecasting and planning accuracy. Real time data can give more accurate demand and supply forecasts and more reliable planning decisions. This is connected to the virtual stock, where stock levels in transit are digitally tracked. Knowing what is physically in stock but also what is currently moving through the supply chain organisations can make better decisions about production, purchasing and customer deliveries.

Table 8 discusses requirements like autonomous docking and departure, automatic localisation, autonomous planning and forecasting and autonomous storage and capacity management all depend on accurate real time visibility. These requirements show that advanced visibility is not just about observing the supply chain but also about enabling more automated and proactive control of operations (Agrawal et al., 2022, p. 15).

Agrawal et al. (2022, p. 16) also identify the technological solutions needed to fulfil these business requirements in Table 9. Connectivity is a requirement, as pallets, products or

other logistics units must be connected to the system to generate visibility, time data collection is then needed to collect information at appropriate time intervals. Collecting data alone is not sufficient. The data must also be stored, protected and managed through effective data management practices.

Table 9. Technological solutions. (Agrawal et al., 2022, p. 16).

Technological solutions	Descriptions
Connectivity	Establish connectivity between pallets and the system
Real-time data collection	Collect real-time data based on decided time intervals
Data management	Store, protect, and manage collected data
Data analytics	Analyse data to visualise the desired function
Data integration	Integrate data with ERP, TMS, and WMS systems

Kalaiarasan, Olhager et al. (2022, p. 4) table 10 on antecedents for SCV complements Agrawal et al.'s findings grouping the factors into people, process and technology categories. The people-related antecedents include culture, inter-organisational collaboration and trust. These factors underscore that SCV requires relationships and behavioural readiness. Visibility cannot be achieved only by implementing systems if the organisational culture does not support transparency or if supply chain partners do not trust one another. The process-related antecedents include business, information sharing, information quality and integration. These show that SCV depends on clear processes, same goals and reliable information flows across organisational boundaries. The technology-related antecedents identified by Kalaiarasan, Olhager et al. include blockchain, collaborative planning systems, connectivity and RFID. These technologies can improve SCV by enabling traceability, real time data exchange, automated identification and joint planning. The table suggests that technology is one part of the SCV foundation. People and process factors are equally important because technology must be supported by trust, collaboration, well matched processes and high-quality information. This reinforces the idea that SCV is a sociotechnical capability rather than a purely digital one.

Table 10. Antecedents for SCV (Kalaiarasan, Olhager et al., 2022, p. 4).

Sub-category	Factor	Source(s)
People	Culture	Doetzer (2020)
	Inter-organizational collaboration	Kaipia and Hartiala (2006), Wang and Wei (2007), Srinivasan and Swink (2018), Swift et al. (2019), Brun et al. (2020)
	Trust	Wang and Wei (2007), Lee et al. (2014), Dubey et al. (2018b), Brun et al. (2020)
Process	Business alignment	Wang and Wei (2007), Lee et al. (2014)
	Information sharing	Kaipia and Hartiala (2006), Barratt and Oke (2007), Brandon-Jones et al. (2014), Dubey et al. (2018a, 2019, 2020)
	Information quality	Barratt and Oke (2007)
	Integration	Wang and Wei (2007), Kim et al. (2011), Williams et al. (2013), Munir et al. (2020)
Technology	Blockchain	Kurpjuweit et al. (2019), Martinez et al. (2019), Van Hoek (2019), De Giovanni (2020), Rogerson and Parry (2020), Wang et al. (2020a,b)
	Collaborative planning system	Barratt and Oke (2007), Barratt and Barratt (2011), Giannakis et al. (2019)
	Connectivity	Kim et al. (2011), Brandon-Jones et al. (2014), Dubey et al. (2018a, 2019, 2020)
	RFID	Fosso Wamba et al. (2008), Caridi et al. (2013), Pero and Rossi (2014), Yu and Goh (2014), Guo et al. (2015), Papert et al. (2016), Van Hoek (2019)

Seems like effective SCV requires more than collecting real-time data. It also requires connectivity, data management, aligned processes, information quality, trust and collaboration. Therefore, SCV requirements should be understood as a combination of business needs, technological solutions and organisational readiness.

2.4.4 Outcomes of effective SCV

Agrawal et al.'s (2022, p. 2933) table 11 on drivers for supply chain visibility explains why organisations seek to improve visibility. The most important driver identified is managing deviations, meaning the ability to detect disruptions early and respond to them appropriately. This shows that SCV is strongly linked to operational control and risk reduction. Another major driver is supply chain control, which includes controlling material, information and payment flows from suppliers to final customers. Customer service is also a

driver, as visibility enables organisations to inform customers about where their goods are and when they will arrive. These drivers show that SCV creates value internally, as well as also externally through improved customer communication and service reliability. The same driver table also includes decision-making support, economic sustainability, risk management, environmental sustainability and social sustainability. These factors show that visibility supports operational and strategic decision-making. For example, accurate visibility makes fact-based decisions in daily operations possible, while also supporting broader goals like profitability, risk management, circular economy and corporate social responsibility. The table suggests that operational drivers, like deviation management, supply chain control and customer service, are rated more highly than sustainability drivers.

Table 11. Drivers for supply chain visibility (Agraval et al, 2022, p. 2933).

Factors	Description / Examples	Mean (Std.dev.)*
Managing deviations	Detect deviations early and act accordingly	6.10 (1.09)
SC control	Control material, information, and payment flows from supplier to final customers	5.90 (1.00)
Customer service	Making information available and visible to stakeholders, including customers e.g. customers know where their goods are and when they will arrive	5.86 (1.06)
Decision-making support	Fact-based decision for operations and strategic activities	5.76 (1.09)
Sustainability: Economic	Profitability	5.48 (1.12)
Risk management	Know and understand full value chain to make proactive decisions, control from a risk perspective	5.38 (0.92)
Sustainability: Environmental	Circular economy	5.33 (1.11)
Sustainability: Social	Corporate Social Responsibility (CSR)	4.67 (1.39)

* Scale: '1' = unimportant, and '7' = extremely important.

Kalaiarasan, Olhager et al. (2022, p. 5) table 12 on drivers of SCV identifies why different actors may be motivated to pursue visibility. Internal drivers include price advantage and purchasing power, suggesting that visibility can positively affect cost control and improve the organisation's negotiating position. Customer-related drivers include compliance,

customer service, market intelligence and modular design. These drivers show that SCV helps companies meet customer expectations, respond to market needs and manage requirements more effectively. Supplier-related drivers include responsible sourcing and supply base management, which show that visibility can help with supplier control, ethical sourcing and supplier relationship management. The supply chain level drivers identified by Kalaiarasan, Olhager et al. include intelligence, risk management and sustainability. This shows that SCV supports the understanding of supply chain and enablers proactive decision-making. Risk management is particularly important because visibility allows companies to identify disruptions earlier and respond before problems escalate. Sustainability is also increasingly relevant, as companies need visibility into suppliers, materials, transportation and production processes to assess environmental and social impacts. The drivers of SCV go beyond operational efficiency and include strategic, ethical and sustainability-related considerations.

Table 12. Drivers of SCV (Kalaiarasan, Olhager et al., 2022, p. 5).

Sub-categories	Factor	Source(s)
Internal	Price advantage	Handfield et al. (2019)
	Purchasing power	Handfield et al. (2019)
Customers	Compliance	Klueber and O'Keefe (2013), Brun et al. (2020)
	Customer service	Caridi et al. (2013)
	Market intelligence	Wei and Wang (2010)
	Modular design	Suh and Lee (2018)
Suppliers	Responsible sourcing	Swift et al. (2019)
	Supply base management	Bartlett et al. (2007), Caridi et al. (2010)
Supply chain	Intelligence	Wei and Wang (2010)
	Risk management	Jüttner and Maklan (2011), Busse et al. (2017)
	Sustainability	Busse et al. (2017), Suh and Lee (2018)

So, effective SCV can create both operational and strategic value. It supports deviation management, supply chain control, customer service, decision-making, risk management and sustainability. These outcomes show that visibility helps organisations understand supply chain conditions earlier and respond to changes more effectively.

3 Method

The research design could be characterised as a qualitative, empirical single case study. The research objectives functioned as guiding propositions. A case study approach was chosen as the methodological strategy because the purpose was to understand supply chain visibility implementation in a real organisational context. Case study research is relevant when the purpose is to explain existing circumstances in depth and to provide a rich understanding of a social or organisational phenomenon (Yin, 2018, p. 35). Similarly, Eisenhardt et al. (1989, p. 534) describe case study research as a strategy focused on understanding the dynamics present within a single setting. This study takes a case study approach loosely inspired by Eisenhardt's theory building logic. Eisenhardt (1989, p. 534) argues that case studies are particularly valuable when the research topic is still emerging, insufficiently understood or characterised by fragmented or conflicting explanations. In this type of situations, close engagement with empirical data can support the development of novel, empirically grounded and later testable theoretical insights (Eisenhardt, 1989, p. 532–550). This logic is well suited to the present study, as the barriers to effective supply chain visibility implementation specifically in complex make-to-order manufacturing environments remain partly understood in the existing literature.

The study focused on one case company and one case unit operating in a complex make-to-order manufacturing environment. Within case study research, an important design decision concerns whether to conduct a single-case or multiple-case study (Yin, 2018, p. 35). Eisenhardt's framework typically relies on multiple cases, with new cases being added until further investigation no longer generates substantial new insights or reveals new patterns (Eisenhardt, 1989, p. 532–550). In this thesis, a single-case study design was chosen. The decision was shaped by both methodological and practical reasons. From a practical perspective, the scope of a master's thesis imposes clear limitations in time, available research hours, report length and funding. Conducting a multiple-case study would have required a broader data collection process and a more extensive comparative analysis than was feasible within the limits of thesis. Also, access to suitable interviewees and case organisations further supported concentrating the study on one

carefully selected case. The aim was to gain deeper understanding. Yin (2018, p. 97) notes that a single-case study can be appropriate under many circumstances, including when the case is critical, unusual, common, revelatory or longitudinal. In the present study, the selected case can be justified primarily as a critical case, while it also contains elements of a common case. The single case design also gave depth over broadness. Yin (2018, p. 171) further notes that single-case studies conducted by a single researcher may benefit from flexibility and sensitivity during data collection and analysis. In the present study, this made it possible to adapt to emerging themes during the interviews and to interpret patterns across functions within the case organisation while maintaining a coherent analytical focus. Flyvbjerg argues that one common misunderstanding of case study research is that a single case cannot contribute to scientific development, even though case studies can provide important context-dependent knowledge (Flyvbjerg, 2006, p. 219).

Figure 7 shows four basic case study designs according to Yin (2018, p. 96). The designs differ based on two choices: whether the study has one case or several cases, and whether the case is studied as one whole unit or through several embedded units. In this thesis, the design is closest to Type 2: embedded single case design, because the study focuses on one case company/unit, but analyses several internal functions, such as logistics, manufacturing, procurement and customer care.

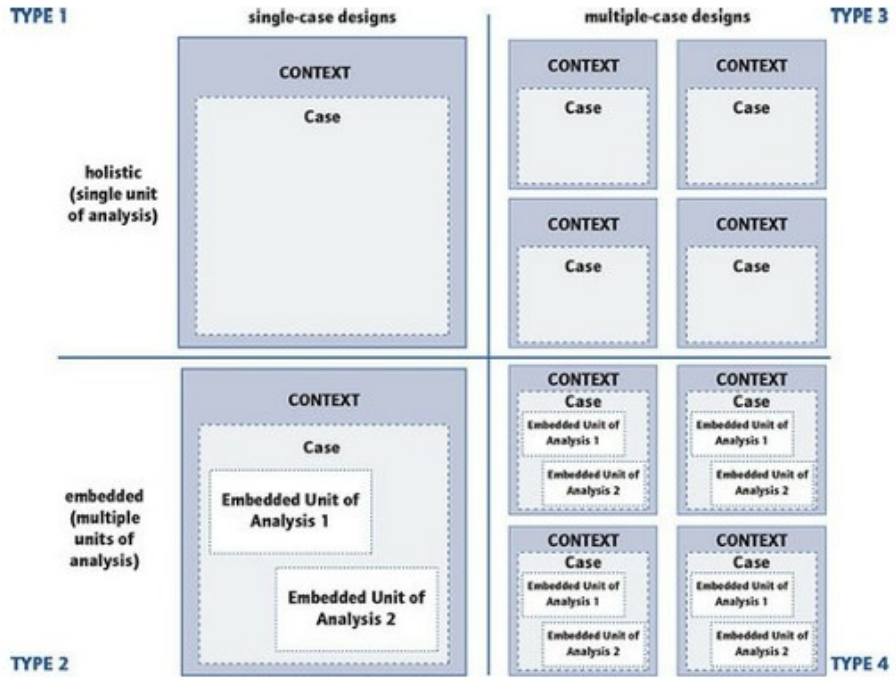

Figure 7. Basic types of designs for case studies. (Yin, 2018, p. 96).

The empirical data was collected through semi-structured interviews. The interview questions were open-ended, which allowed the participants to describe their own experiences and views in detail. The interviews were conducted in the language in which the participants felt most comfortable. In practice, all eight interviews were conducted in Finnish. This was done to reduce the risk of misunderstandings and to allow the participants to describe their experiences, examples and work terminology as naturally and accurately as possible. This was important because the quality of qualitative interview data depends strongly on the depth and clarity of participants' own descriptions. The same interview questions were used for all participants to make the answers comparable, while the semi-structured format allowed some flexibility during the discussions.

Eisenhardt (1989, p. 538–539) further highlights that theory building case research benefits from an iterative process in which data collection and data analysis overlap. This overlap gives the researcher an early start in analysis and, more importantly, makes it possible to adjust the data collection process when relevant themes begin to come up (Eisenhardt, 1989, p. 539). The present study followed this principle in a limited but meaningful way. As interviews progressed, the material was reviewed continuously and

early observations helped refine the interviews. This allowed the researcher to probe themes that appeared particularly relevant.

The study was also inspired by grounded theory thinking, particularly in its openness to emergent themes and its iterative movement between data collection and analysis. The study was not a pure grounded theory study. Unlike a fully grounded theory design, the research did not start without prior theoretical orientation. Instead, the literature review, the research question and the study objectives provided an initial analytical frame for the inquiry. The grounded theory influence is visible mainly in the inductive elements of process - patterns were allowed to emerge from the interview material and the analysis remained open to findings that were not fully anticipated at the outset. For this reason, the study can be described as an abductive and theory building case study rather than a strict grounded theory study.

In total, eight interviews were conducted. The interviewees were selected widely from the teams that are directly involved with supply chain visibility in the case unit. Aim was to interview two participants from each key function, that are logistics, manufacturing, procurement and customer care. Flynn et al. (2010, p. 58) highlights that supply chain integration includes internal integration, supplier integration and customer integration, which supports studying visibility across several internal and external interfaces. The conducted interviews included one logistics manager, one manufacturing manager and one manufacturing office worker, one procurement manager and two procurement office workers and one customer care manager and one customer care office worker. This selection made it possible to collect views from managerial and employee standpoints. It also allowed comparison between different functions that are connected to supply chain visibility in daily operations. Frohlich and Westbrook's idea of "arcs of integration" is useful here because it shows that supply chain integration can be understood by its direction and degree toward suppliers and customers, which supports studying visibility from both upstream and downstream perspectives (Frohlich & Westbrook, 2001, p. 185).

The number of interviews was considered sufficient for the scope and purpose of this thesis because the study used purposive sampling rather than statistical sampling. In qualitative research, sample adequacy is not mainly determined by the percentage of the total population interviewed, but by the relevance and information richness of the participants. Malterud et al. (2016, p. 1753–1754) describe this as information power, the more relevant information the sample provides for the research aim, the fewer participants are needed. In this study, the interviewees were selected from functions directly connected to supply chain visibility, which increased the information power of the sample.

The final sample included eight interviews, and this number was considered appropriate for an exploratory single-case master's thesis because the research aim was focused, the case context was clearly defined, and the interviewees represented the key functions involved in the visibility problem. Previous methodological research also suggests that relatively small interview samples can be sufficient in focused qualitative studies. Guest et al. (2006, p. 59-61) presents that basic elements of meta themes were present as early as six interviews, while saturation occurred within the first twelve interviews. Hennink and Kaiser (2022, p. 1) also found that saturation in qualitative studies is often reached with relatively small samples, especially when the study population is relatively homogeneous and the research objectives are narrowly defined.

The selection of interviewees from procurement, production, customer care and logistics was also methodologically justified by the nature of supply chain visibility. SCV is not limited to one function, but includes supplier, internal and customer information. Agrawal et al. (2022, p. 2932) identify customer-related, internal and supplier-related data elements as important for SCV. Procurement was included because it is closely connected to supplier information and material availability. Production was included because internal capacity, production plans and material use affect visibility inside the unit. Logistics was included because it is connected to material and delivery flows. Customer care was included because customer communication and delivery promise depend on

accurate visibility information. This cross-functional selection supported a broader understanding of how SCV barriers appear in daily operations.

Before the interviews, permission to conduct the study at the case company was requested and granted. Each interview candidate was asked whether they were willing to participate voluntarily. The participants were also sent a cover letter explaining the purpose of the study, their rights as participants and how the interview data would be handled. Participation was voluntary.

Yin (2018, p. 184) suggests that shorter case study interviews are often usefully limited to about one hour. Each interview was planned to last approximately 45 minutes, but a one-hour meeting slot was booked for each participant to allow flexibility if more time was needed.

The interviews were conducted remotely through Microsoft Teams. Remote Teams meetings were used because they enabled automatic transcription and made the data collection process practical and consistent. After the interviews, the transcription data was reviewed and modified by the researcher. All information that could reveal company secrets, the identity of the company, the case unit or individual participants was removed or anonymised. This ensured that the company and the interviewees could not be recognised from the material. The original transcripts are not published in the thesis and only anonymised and analysed findings are presented.

The interview data were analysed manually using open and axial coding. Open coding was used to identify initial concepts and themes from the interview transcripts, while axial coding was used to refine these codes and group them into broader categories. Open coding is the first stage of coding, where the researcher goes through the data and identifies meaningful words, phrases, concepts and emerging themes. These are organised into initial broad thematic groups. Axial coding is the second stage, where the researcher refines and connects the open codes. Similar or related codes are grouped into

clearer categories and relationships between themes are identified. (Williams & Moser, 2019, p. 48–51).

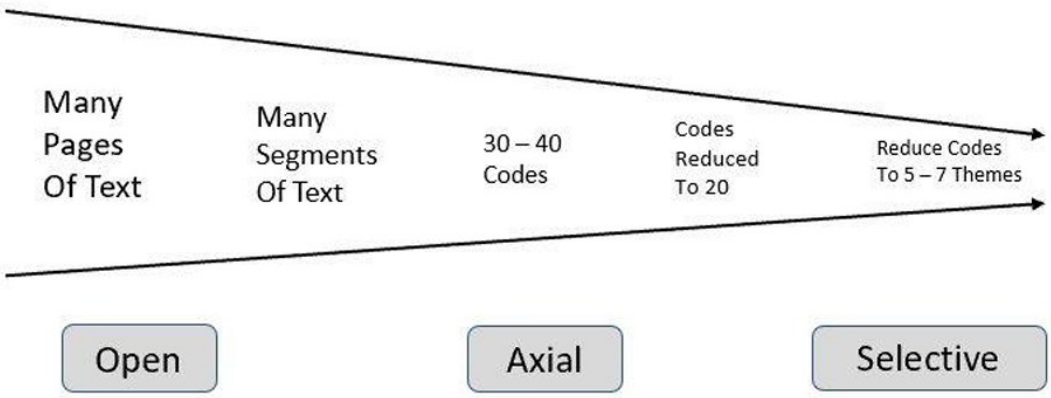

Figure 8. Overview of coding process: Open, Axial and Selective Coding. (Williams & Moser, 2019, p. 47).

So, the chosen method supported the aim of understanding SCV implementation barriers in their real organisational context. The semi-structured interviews, cross-functional participant selection and manual coding process made it possible to identify recurring themes across the case unit. The next chapter presents the empirical findings based on this research design and analysis process.

4 Results

This chapter presents the empirical findings. First the main SCV barriers identified from the interview data are presented. Then organisational practices supporting SCV in the case company are discussed. Thirdly the empirical findings are compared with the literature review. The theoretical contributions are presented, and the quality and ethical considerations discussed.

Yin (2018, p. 79) argues that a common mistake in case study research is to treat case study findings as if they could be statistically generalised to a wider population. This is problematic because case studies do not rely on sampling units in the same way as quantitative studies and the number of cases is usually too small to represent a larger population. The value of case study research does not come from statistical ability to represent a larger population, but from its ability to contribute to theory. For this reason, the aim is not to produce statistically generalisable findings. Instead, the aim is to show how visibility problems appear in daily operations within their real-life context, how they are connected to organisational practices and how the findings could support future multiple-case research.

4.1 SCV Barriers in case company

Many barriers came up in the interviews, as presented in Table 13, and there was clear repetition in the answers about these. One visibility barrier is toward suppliers. The case unit does not have direct system access to supplier information. Supplier safety stock levels are not visible unless suppliers communicate them separately. This makes the unit dependent on supplier updates. These updates can have major gaps in important information and might not be proactive, depending on the supplier.

Another barrier is related to processes. The interviews show that data errors can occur when standard processes are bypassed or handled in different ways. In a standard

process, tasks usually go correctly because the process has been checked and designed to work properly. However, problems can appear when the standard process is skipped, for example because of urgency or special situations. Instead of using ERP system, some tasks may be handled manually through email or informal communication between manufacturing, logistics or other functions. In these situations, the system does not protect data quality in the same way. If the process is handled manually, the result depends more on individual employees, and human errors can happen. Similar problems can also occur in special cases, such as testing situations, where some required steps may be forgotten. The interviews suggest that bypassing standard processes happens relatively often. This can create errors, delays and inaccurate system data. Therefore, process deviations should be reduced and used only when they are clearly necessary, not on a whim or nice to have basis.

Another process matter is the lack of a clear process for communicating changes. There is no standardised method for change management on smaller matters, like changes in material structures, changes in production process or material quality issues. Instead, information may be communicated randomly in meetings, Teams messages, emails or discussions. This creates inconsistency in who receives the information and at what point.

Many barriers are also connected to the ERP system and data structure. The ERP system was described as heavy and rigid to use. This makes data maintenance slower and more difficult. If updating data takes too much time, employees may struggle to keep information up to date while also handling daily tasks. The lack of efficient mass-editing tools increases this problem. If small changes to the information is too time consuming to make, they usually do not end up being done at all. Another issue is that the system structure does not fully work with the current production environment. Production has developed a lot in recent decades, but the system has not developed at the same pace. It becomes harder to use it as a reliable visibility tool. Employees may then create workarounds outside the ERP system. These may help in the short term, but they also spread information across different places.

Limited ERP competence also affects visibility. Employees usually know the ERP functions needed for their own work, but they may not understand how the system works across different functions. This is understandable but it can limit visibility. Data entered by one team may affect another team's work. If employees only understand their own part of the system, they may not see how missing or incorrect data affects the wider supply chain.

The case company also has some other systems attached to the main ERP system. However, the connections between these systems do not always work perfectly. If information is not transferred correctly from one system to another, the data can become incomplete, outdated or incorrect. This weakens visibility by weakening data quality and reduces trust in the system and causes excess work to constantly fix these problems.

A major barrier is that not all the important information is in the ERP system. Some information is stored in Excel files, Outlook emails, separate documents, informal communication channels or only in people's heads. This weakens visibility because the information is not equally available to everyone. It is also harder to use for reporting and analysis. For example, in the case unit workforce data is not systematically shown in the ERP system, even though it affects capacity and production planning. When information is outside the main system, visibility depends on knowing where to look or whom to ask.

Limited resources also limit visibility. Time pressure, high workload and constant urgency leave less time for data maintenance and long-term development. Employees and managers often need to focus on immediate operational problems. As a result, data quality and visibility improvements may be delayed. This is important because visibility problems usually cannot be fixed once and then forgotten. They require continuous maintenance, follow up and development.

Culture was also identified as a barrier. One issue is the acceptance of inaccurate data. If incorrect or incomplete data is seen as a normal part of daily work, there may be less pressure to fix the root causes. This does not mean that employees do not care about data quality. It may simply mean that people have become used to checking and correcting information manually. From a visibility perspective, this is a problem. If inaccurate data is accepted, the system cannot be a reliable basis for planning and decision making.

The final barrier is top management commitment. Many visibility problems are cross-functional and structural, so they cannot be solved by one person or one team alone. Management involvement is needed to make data quality and visibility visible priorities. If management does not require these issues to be monitored, they may not receive enough attention in daily work. Without clear metrics, routines and follow up, improvement work may depend too much on individual effort. The unit's focus on production growth also affects visibility development. Production growth and capacity increase are understandable priorities in the current situation. Resources are mainly directed toward immediate production needs. In the long term, growth may become harder to manage if visibility and system do not develop at the same pace.

Table 13. SCV barriers in the case company, identified from the interview data.

Main category	Barrier	Description
Limited visibility to outside of the unit	**Limited supplier visibility**	Visibility toward suppliers is incomplete, as the case unit does not have direct system-based access to all relevant supplier information. For example, supplier safety stock levels are not visible unless suppliers communicate them separately. This creates dependency on supplier-provided updates and limits the organisation's ability to anticipate shortages.
Processes	**Deviations from standard processes create data errors and unpredictability**	When normal processes are bypassed or handled differently, data errors may occur and the predictability of operations decreases. Process deviations can reduce the reliability of system data and make it more difficult for other functions to form an accurate view of the supply chain situation.
	Lack of a clear process for communicating changes	Changes affecting the supply chain are not always communicated through a clearly defined process. Without a standardised change notification procedure, relevant information may reach different teams too late, inconsistently or only through informal communication channels.
Systems and data architecture	**Cumbersome and rigid ERP system usage. Lack of mass-editing tools.**	The main ERP system is perceived as heavy and inflexible to use. This can reduce the efficiency of data maintenance and make it more difficult for employees to keep information updated as part of their daily work. The absence of efficient mass-editing tools makes data maintenance more time-consuming. When larger data updates must be performed manually or through inefficient methods, the risk of outdated or incomplete data increases.
	Legacy system structure does not reflect current production development	Although production operations have developed importantly, the system structure has not been updated to the same extent. This creates a mismatch between current operational reality and the system logic, which may limit the system's ability to support visibility effectively.
	Limited overall ERP SYSTEM competence	Employees often know only the ERP SYSTEM functions that are mandatory for their own tasks. This task-specific knowledge may be sufficient for daily work, but it can limit the organisation's ability to use the system more comprehensively for visibility, analysis and cross-functional problem-solving.
	Technical integration problems between systems	Integration problems between systems can create data errors and reduce trust in available information. When connected systems do not communicate reliably, the data visible to users may become incomplete, inconsistent or incorrect.
	Fragmented information outside ERP SYSTEM	Not all relevant information is available in ERP system. Instead, important data may be stored in Excel files, Outlook emails, separate documents, informal communication channels or only in employees' personal knowledge. This fragmentation weakens visibility because information is not equally accessible, standardised or available for reporting and analysis. For example, workforce-related data is not systematically represented in ERP SYSTEM, even though it affects capacity and operational planning.

Main category	Barrier	Description
Resources	**Time pressure and operational workload**	Lack of time and constant urgency reduce the ability to maintain data quality and improve visibility. Employees and managers often need to prioritise immediate operational issues, which leaves less time for systematic data maintenance and long-term development work.
Culture	**Acceptance of data inaccuracies**	One cultural barrier is the normalisation of incorrect or incomplete data. If inaccurate data is accepted as part of everyday operations, there may be less pressure to correct root causes or maintain high data quality consistently.
Top management commitment	**Limited management involvement in data quality and visibility**	Visibility development requires active management involvement. If management does not systematically require data quality or visibility to be monitored, these issues may not receive enough attention in daily operations or improvement initiatives.
	Lack of formal monitoring of data cleanliness and visibility	Data cleanliness and supply chain visibility are not necessarily followed through clear management-level metrics or routines. Without formal monitoring, accountability for data quality may remain unclear and improvement efforts may be inconsistent.
	Production growth prioritised over visibility development	The unit's main priority is production growth and capacity increase. While this is operationally understandable, it may slow down development projects related to data quality, system improvement and supply chain visibility, as resources are directed toward immediate production needs.

4.2 Organisational Practices Supporting SCV in the case company

The interview findings show that many organisational practices in the case unit already support supply chain visibility, even though earlier discussed issues remain. These practices are mainly connected to clear responsibilities, resource allocation, active communication, trust between functions and a positive attitude toward continuous improvement. These factors form an important organisational foundation for visibility, as supply chain visibility is created through systems and data but also by the way people communicate, take responsibility and cooperate across functional boundaries.

One of the clearest positive findings from the interviews was that responsibilities for different data points seem to be relatively well defined. When errors or inaccuracies are identified in the system, employees generally know who should be contacted to correct the issue. This is important from the perspective of supply chain visibility because unclear data ownership can easily lead to situations where incorrect information remains in the system, as no one knows who is responsible for correcting it.

Another important practice is the use of interns and other extra resources to reduce the operational workload of permanent employees and managers. Many interviewees referred to interns as a useful resource, particularly in relation to more manual and operational tasks. This is important because lack of time and competing priorities were also identified as barriers to data maintenance and visibility development. When employees are under constant time pressure, system updates and data quality tasks may be delayed or handled less systematically. By assigning some of the more routine or manual work to interns, the case unit is able to release capacity for employees to focus on tasks that require more experience. If operational workload increases and extra resources are not available, the ability to maintain data quality and improve visibility may weaken.

Communication also seems to be universally seen as one of the strongest organisational practices supporting visibility in the case unit. The interviews show that there is a high

level of communication between the different internal functions, as well as between the unit and its customers and suppliers. Cross-functional meetings, supplier meetings, customer meetings, informal discussions, Teams communication and direct contact between individuals all contribute to the flow of information. This frequent communication helps compensate for situations where information is not fully available in the system or where additional clarification is needed. For example, if system data is incomplete, outdated or difficult to interpret, employees can often obtain the required information by contacting the relevant person directly. In the current operating environment, this active communication appears to be essential for maintaining day-to-day visibility.

The interviews also bring up that cooperation between functions is generally strong. The different teams appear to trust one another within the unit and are willing to help each other when information is needed. It also depends on whether people are willing to share information, respond to requests and help other functions understand the current supply chain situation. Trust between internal functions reduces barriers to communication and makes it easier to solve problems quickly. The case unit's collaborative culture can be seen as an important enabler of visibility. Li and Lin (2006, p. 1652) found that information sharing and information quality in supply chain management are influenced by factors such as trust, shared vision and organisational support.

At the same time, the high number of meetings and the heavy reliance on direct communication should also be interpreted critically. While active communication currently supports visibility, it may show that information is not always available through standard processes or shared systems. Ideally, the required information would be stored, updated and accessible in ERP system or another shared system, allowing employees to retrieve reliable data without needing to arrange separate discussions or wait for individual responses. The fact that many issues require meetings or direct clarification suggests that communication is partly compensating for weaknesses in process standardisation, system usability or data availability.

A further positive finding concerns the unit's attitude toward development and change. The interviews suggest that there is considerable willingness to improve current ways of working and very limited resistance to change. When improvement ideas are proposed, employees and teams are generally open to testing and implementing them. This is an important organisational strength, as supply chain visibility development often requires changes in routines, responsibilities, system usage and cross-functional practices.

The current development culture is practical and gradual. Interviewees showed that improvements are often made as small fixes alongside daily work. This type of continuous improvement is valuable because it allows the organisation to solve concrete problems quickly and adapt to operational needs. Small improvements can also gradually strengthen visibility by correcting data issues, improving communication practices or making local process adjustments. The interviews also suggest that this approach has limitations. Many improvements are made alongside other responsibilities, rather than through clearly planned and resourced development projects. So, the changes may solve immediate symptoms but may not fully address deeper root causes. This creates a distinction between local improvement activity and broader organisational development. The case unit appears to have a strong willingness to improve but the development work is often fragmented and operationally driven. For supply chain visibility to improve more substantially, small fixes may need to be complemented by more structured and project development.

4.3 The need for visibility

In the interviews there was clear repetition in answers that material shortages that the unit is experiencing are causing major visibility issues. In a normal situation the supplier as well as the manufacturing unit itself has safety stock of needed materials. This works as a buffer for any supplier issues, like material availability issues on the supplier side or quality issues. But since the supplier output has not been able to keep up with the growing demand despite clear planning and efforts, they are struggling to keep up with the

planned production times. In this situation, clear communication towards customers is crucial and more exact and precise visibility of material availability data is needed than normal. So, this issue creates the need for more visibility but is not a visibility barrier in itself.

This distinction is important for the analysis. The material shortage is mainly an operational problem, but it reveals how dependent the case unit is on accurate, timely and shared SC information. When materials are available and there is safety stock, small visibility gaps may not cause problems. However, when the supply situation becomes tight, the need for reliable visibility increases significantly. So, material shortages should still be addressed by the case company, even if they are not classified as a direct SCV barrier.

4.4 Comparison of Empirical Findings with Literature

The empirical findings have many similarities with the existing literature on supply chain visibility. The literature review shows that visibility problems were not only caused by ERP limitations, but also by unclear processes, fragmented communication and management priorities. In the case company the barriers were connected to supplier visibility, process standardisation, ERP systems, data architecture, resources, culture and management commitment. These findings support the view that SCV depends on people, processes and technology (Kalaiarasan, Olhager et al., 2022, p. 4). So, very similar findings.

What also came up in the interviews was limited visibility toward suppliers. The case unit does not have direct system access to all relevant supplier information, like supplier safety stock levels, supplier capacity or early delivery risks. In literature Kalaiarasan, Olhager et al. (2022, p. 1) note that upstream visibility toward suppliers is often limited and that lower-tier suppliers are especially hard to monitor. Also, Agrawal et al. (2022, p. 2927) state that SCV requires visibility of upstream operations, downstream operations and internal business processes. The case unit's internal planning depends on supplier information, but this information is not always directly available. Supplier visibility

appears as one of the biggest barriers in the case company. This research adds to that that supplier visibility becomes especially critical when material availability is already under pressure. In normal conditions, safety stocks can hide some visibility gaps, but during shortages the same gaps become much more visible and harmful.

Literature on data quality and standardisation is also discussed in literature. In the case company, data errors can occur when standard processes are bypassed or handled differently. This creates problems because the ERP system may no longer show the real operational situation. The literature identifies lack of data standardisation, poor data quality and lack of ability to combine data as most important barriers to SCV (Delgado et al., 2025, p. 6–7; Kalaiarasan, Olhager et al., 2022, p. 5). Agrawal et al. (2022, p. 2934) also identify data quality as the highest rated enabler of SCV. This means that the results are consistent with the literature: visibility is only useful if the data is accurate, timely, consistent and reliable. In this case, data quality problems were also caused by situations where normal processes were bypassed. This shows that data quality depends on system design as well as daily process discipline.

The case company interviews show that process-related barriers play an important role. The lack of a clear process for communicating smaller changes, like changes in material structures, production processes or material quality issues, creates inconsistency in information flow. This finding is connected to the literature on information sharing and integration. Kalaiarasan, Olhager et al. (2022, p. 4) identify information sharing, information quality and integration. Agrawal et al. (2022, p. 2934) also highlight information sharing and standardisation as important enablers. The empirical findings show that even when employees are willing to communicate, visibility can still suffer if communication is not supported by standardised processes. So, willingness to communicate is not enough if there is no agreed process for what information should be shared, where it should be saved and who should get it.

Many of the identified barriers were related to ERP systems and data architecture. The main ERP system was described as heavy and rigid and the lack of efficient mass-editing tools made data maintenance more difficult. Aldo, the system structure has not developed at the same pace as production operations. This is aligned with the literature on technological barriers. Delgado et al. (2025, p. 6–7) identify lack of adequate infrastructure, technical knowledge and the inability to combine data across the supply chain as major barriers. Agrawal et al. (2022, p. 2935) also identify insufficient IT infrastructure and data from multiple sources as challenges to SCV. The empirical findings show that ERP system and related integration issues directly affected the reliability and information availability. ERP system can become a visibility barrier when the production environment develops faster than the system structure.

A particularly important thing that came up in the interviews was that not all relevant information is available in the ERP system. Some information is stored in Excel files, Outlook emails, separate documents, informal communication channels or only in employees' personal knowledge. This is connected to the literature on fragmented information. Kalaiarasan, Olhager et al. (2022, p. 5) identify diverse sources of information as a supply chain level barrier. Delgado et al. (2025, p. 6–7) brings up the lack of ability to combine data across the supply chain. In the case company when important information is outside the main system, visibility becomes dependent on personal communication and local knowledge rather than shared, standardised and reliable data. This shows why informal workarounds can be problematic.

In the case company, employees usually know the ERP functions needed for their own daily tasks, but they may not understand how the system works across functions. This limits cross-functional visibility because data entered by one team may affect the other team's work. Delgado et al. (2025, p. 6–7) identify lack of technical knowledge and training as a barrier and Kalaiarasan, Olhager et al. (2022, p. 5) highlight lack of skills and knowledge as a challenge. The case findings show that competence shouldn't only mean knowing how to use one's own part of the system. For SCV, employees also need some

understanding how information flows across functions. This suggests that ERP competence should be understood as cross-functional competence.

Interviewees described that urgent daily problems often take priority over data maintenance, which makes visibility development difficult even when the need is recognised. Time pressure, high workload and operational urgency reduce the time available for data maintenance and long-term visibility development. This is aligned with the literature, where budget constraints, limited resources and implementation costs are often identified as barriers to SCV (Kalaiarasan, Olhager et al., 2022, p. 5; Delgado et al., 2025, p. 6–7). The findings add a detail: even when the organisation has general resources, daily urgency can prevent employees and managers from using enough time for visibility improvement. It's not just about financial resources, but also about available attention, time and prioritisation.

The acceptance of inaccurate data was identified as a cultural barrier. If incorrect or incomplete data is seen as normal, there may be less pressure to correct root causes. Agrawal et al. (2022, p. 2935), who identify organisational culture as a challenge to SCV. The management's role in commitment is also brought up in the literature. Agrawal et al. (2022, p. 2934) identify top management support as an enabler of SCV. In the case company, many visibility problems are cross functional and structural, meaning that they cannot be solved by one team alone. Management support is needed to set priorities, create routines, define metrics and give resources for visibility development.

The results show several organisational practices that support SCV. Clear responsibilities for data points help employees know who to contact when errors are found. This relates to the literature on information quality, integration and organisational practices (Kalaiarasan, Olhager et al., 2022, p. 4). The use of interns also helps reduce workload and indirectly supports data maintenance. The resource related barriers identified by Delgado et al. (2025, p. 8) but from the opposite perspective: when sufficient resources are available, visibility work becomes easier.

Communication, cooperation and trust were among the strongest SCV supporting practices in the case company. These are aligned with the literature. Agrawal et al. (2022, p. 2934) identify information sharing, trust and interorganisational collaboration as enablers of SCV. Kalaiarasan, Olhager et al. (2022, p. 4) also identify culture, collaboration and trust as people-related things. In the case unit, active communication between functions helps maintain daily visibility, especially when system information is incomplete. The findings also add a point that heavy reliance on meetings and direct communication may also indicate that information is not sufficiently available through standard systems. In this way, communication acts as an enabler and as a sign of underlying system or process limitations.

4.5 Theoretical Contributions

A theoretical contribution does not always need to mean creating a completely new theory. It can also mean improving, extending or clarifying existing theory by showing what factors matter, how they are connected, why they matter and in what kind of context they appear (Whetten, 1989, p. 490–493). The theoretical contribution of this thesis can be understood through Whetten's view of what makes a study theoretically useful. Whetten (1989, p. 490–493) argues that theoretical contribution is not only about identifying more factors, but also about explaining what factors matter, how they are related, why they matter and under what conditions they apply. From this perspective, the contribution of this thesis is not only that it identifies SCV barriers in the case company. The study also shows how these barriers are connected to each other in a complex make-to-order manufacturing environment. This is important because many earlier SCV studies identify barriers such as poor data quality, lack of standardisation, insufficient IT infrastructure, lack of collaboration, limited resources and supply chain complexity. This thesis supports these earlier findings, but it also gives a more detailed explanation of how such barriers appear in daily work. For example, ERP system limitations can make data maintenance more difficult, time pressure can reduce attention to data quality, and

acceptance of inaccurate data can allow the same problems to continue. In this way, the study shows that SCV barriers are not separate issues but connected problems that can reinforce each other.

Following Whetten's (1989, p. 490–493) view, the contribution of this thesis is also connected to contextual conditions. The findings show that SCV barriers become more important under certain operational conditions. In the case unit, strong production growth directs attention toward immediate capacity increase and daily production needs. This can move attention, time and development resources away from long-term SCV improvement, even though visibility development is needed to support that same growth. At the same time, material availability challenges increase the need for more precise visibility. When materials are available and safety stocks are sufficient, some visibility gaps may remain hidden. However, when material supply is under pressure, the need for accurate, timely and supplier-related visibility becomes much more critical. This shows that SCV barriers should not be studied only as general barriers, but also in relation to the operational context where they appear.

Corley and Gioia (2011, p. 12–13) explain that theoretical contribution depends on originality and utility. From this perspective, this thesis contributes by offering empirically grounded and useful understanding of how SCV barriers appear and interact in a complex make-to-order manufacturing context. The contribution is not the creation of a completely new theory, but the clarification and extension of existing SCV literature through a detailed case study.

Dubois and Gadde (2002) describe systematic combining as an abductive approach to case research. In this approach, the research process does not move in a straight line from theory to data or from data to theory. Instead, the researcher moves back and forth between the theoretical framework, empirical findings, research questions and the case context. The purpose is to gradually improve the match between existing theory and the empirical case. This is useful in case study research because the understanding of the

phenomenon can develop during the research process, as new findings emerge from the data. Dubois and Gadde (2002, p. 554) describe this process as non-linear and path-dependent, meaning that earlier choices and emerging findings can influence how the study develops later. This approach is relevant for the present thesis because the study was not purely deductive or purely inductive. Existing SCV literature was used as a theoretical starting point, but the interview data was also allowed to bring forward case-specific findings. For example, the empirical analysis showed how poor system-based visibility can increase the need for direct communication, which then creates time pressure and may further limit visibility development. In this way, the study used both earlier theory and empirical findings to develop a more practical and context-specific understanding of SCV implementation barriers. Therefore, the thesis can be understood as an abductive case study that elaborates existing SCV theory through empirical case evidence.

This thesis adds empirical evidence to a research area where more empirical case studies are still needed. Earlier research has already identified many SCV barriers, such as poor data quality, lack of standardisation, limited IT infrastructure, lack of collaboration, lack of skills and supply chain complexity (Delgado et al., 2025, p. 6–8; Kalaiarasan, Olhager et al., 2022, p. 5). However, previous literature also shows that SCV research is still fragmented and that more empirical research is needed to understand the factors and their relationships in practice (Kalaiarasan, Olhager et al., 2022, p. 7–9; Agrawal et al., 2022, p. 2939). Ketokivi and Choi (2014, p. 232) explain why case research is a valid scientific method, especially in operations management. They explain that case research can contribute to theory not only through theory generation, but also through theory elaboration. From this perspective, this thesis contributes by using empirical case evidence to elaborate how known SCV barriers appear and interact in a complex make-to-order manufacturing context.

Siggelkow (2007, p. 20) explains that case studies are valuable because they allow the researcher to get close to real-life events, relationships and mechanisms. This makes case studies useful for showing how theoretical ideas work in practice. However,

Siggelkow also warns that a single case should not be used as the only proof that a theory is correct. The theoretical argument must still be logically convincing, and the case should support, illustrate or motivate that argument. This is important for the present thesis because the studied concept cannot be treated as completely new theory based on one case alone. Instead, the contribution is additive: the thesis adds empirical and practical context to existing SCV theory by showing how known visibility barriers appear and interact in one complex make-to-order manufacturing unit. For this reason, further research, especially multiple-case research, is still needed to strengthen and refine the theoretical contribution.

This thesis supports the view that SCV is a socio-technical capability. The findings show that visibility is not created only through ERP systems, digital tools or access to data. Instead, visibility depends on supplier information, standardised processes, reliable data, system usability, employee competence, communication practices, organisational culture and management commitment. This supports the people, process and technology view of SCV presented by Kalaiarasan, Olhager et al. (2022, p. 4). It also connects with earlier research showing that visibility needs information quality and wider supply chain understanding, not only information systems (Caridi et al., 2010, p. 593). So, the thesis contributes by showing that technical systems alone are not enough if the organisational and process-related conditions do not support visibility.

The empirical categorisation of SCV barriers developed from the case data. The main categories identified in this thesis were limited visibility outside the unit, process-related barriers, systems and data architecture, resources, culture and top management commitment. This categorisation is useful for theory because it groups individual barriers into broader categories that can be studied further in future research. The findings also show that SCV barriers are not separate problems. For example, a rigid ERP system can make data maintenance difficult, time pressure can reduce attention to data quality, and acceptance of inaccurate data can allow the same problems to continue. In this way, the

thesis shows how SCV barriers can reinforce each other. This supports and strengthens existing literature on SCV barriers.

Earlier literature often presents information sharing, collaboration and trust as enablers of SCV (Agrawal et al., 2022, p. 2934; Kalaiarasan, Olhager et al., 2022, p. 4). This thesis supports that view, because active communication and trust between functions were found to support visibility in the case unit. However, the findings also add a more critical point by showing a possible self-reinforcing cycle. When system-based visibility is poor, employees need more meetings, Teams messages, emails and direct personal communication to find the needed information. This creates more time pressure and interrupts daily work, which can then reduce the time available for data maintenance, process development and visibility improvement. As a result, poor visibility can lead to more communication, more time constraints and eventually even weaker visibility. This adds nuance to earlier literature because communication is not always only a positive sign. Sometimes it also shows that system-based visibility is missing.

Another contribution is the finding that resource-related SCV barriers are not only financial. Previous literature often discusses budget constraints and implementation costs as resource constraints to barriers of visibility (Delgado et al., 2025, p. 6–8; Kalaiarasan, Olhager et al., 2022, p. 5). In this case, the organisation is a large global company with good financial resources, but daily time pressure, operational urgency and production growth still limit visibility development. This suggests that SCV implementation may be slowed down even in resourceful organisations if management attention, time and development capacity are mainly directed toward immediate operational needs. This is theoretically useful because it shows that the resource barrier is not only about money. It is also about attention, prioritisation and the ability to use resources for long-term development. This connects with the resource-based view, where resources create value only when they are organised and used effectively (Brandon-Jones et al., 2014, p. 55).

Edmondson and McManus (2007, p. 1155–1156) argue that methodological fit means internal consistency between the research question, prior literature, research design and intended contribution. This supports the methodological choice of this thesis, because the research aim was exploratory and focused on understanding SCV implementation barriers in their real organisational context.

This thesis contributes to SCV theory by developing existing knowledge through a detailed empirical case. The study confirms several barriers already identified in earlier literature, but it also shows how these barriers appear, interact and become stronger in a complex MTO manufacturing unit. The findings can therefore support future multiple-case research, where the categories and relationships identified in this thesis can be compared and refined in other manufacturing contexts.

4.6 Quality and ethics of the study

The quality of this study was considered through the logic of qualitative case study research. According to Yin (2018, p. 87), the quality of case study research can be evaluated through construct validity, internal validity, external validity and reliability. In this thesis, construct validity was supported by clearly connecting the research question, interview framework, coding process and empirical findings to the same main topic (barriers to effective supply chain visibility implementation). The interviews focused on employees whose daily work is directly connected to supply chain visibility, which helped ensure that the data was relevant to the research objective.

The credibility of the study was strengthened by collecting data from several functions inside the case unit. The interviewees represented logistics, manufacturing, procurement and customer care and included managerial and employee level perspectives. This made it possible to compare how similar SCV related issues appeared across different functions. Tracy (2010, p. 839–840) states that high quality qualitative research should show rich rigor, credibility and meaningful coherence. A clear interview structure was

used in this study, asking the same main questions from all participants, recording and transcribing the interviews and analysing the data through open and axial coding.

Reliability was kept up by keeping the data collection process consistent. All interviews were conducted remotely through Microsoft Teams, the same interview framework was used for all participants, and each interview was planned to last approximately 45 minutes. A one-hour meeting slot was reserved to allow flexibility. The interviews were conducted in Finnish, because Finnish was the language in which all interviewees felt most comfortable. This improved the quality of the answers, because participants were able to explain their experiences, examples and work-related terminology naturally and accurately. The Teams transcriptions were reviewed, mistakes in transcription corrected and anonymised by the researcher before analysis.

The study also has limitations that affect its quality. It is based on one case company and one case unit. So, the findings cannot be statistically generalised to all manufacturing companies. Yin (2018, p. 79–80) notes that case studies are not generalised statistically but analytically, by connecting findings to theoretical propositions. The purpose of this thesis is not to make broad population level claims but to provide in depth understanding of SCV barriers in one complex make-to-order manufacturing context. Second, the study is based on eight interviews. Although the interviewees were selected from the most relevant functions, a larger sample, within the unit or within the whole organisation, could have produced more perspectives. Third, the analysis was conducted manually by one researcher. This creates a possibility of researcher interpretation bias. To reduce this risk, the analysis followed a structured coding process, and the findings were compared with the literature review.

Ethical issues were also considered throughout the research process. The Finnish National Board on Research Integrity states that good research practice includes reliability, honesty, respect and accountability and that research should be designed, carried out and documented carefully (Finnish National Board on Research Integrity, 2023, p. 11–

12). In this study, permission to conduct the research in the case company was requested and granted before the interviews. Each interview candidate was asked whether they were willing to participate voluntarily. The participants were also sent a cover letter explaining the purpose of the study, their rights and how the interview data would be handled.

Confidentiality was especially important because the study involved a real company and employees discussing internal supply chain issues. Tracy (2010, p. 847) highlights that ethical qualitative research should consider informed consent, voluntary participation, privacy and confidentiality. In this thesis, all identifying information was removed from the interview transcripts. This included the company name, unit name, personal names and any information that could reveal confidential company matters. The original interview transcripts are not published in the thesis. Only anonymised and analysed findings are presented.

Data handling was also guided by confidentiality. The Finnish National Board on Research Integrity (2023, p. 14) states that research partners should agree on data ownership, use, processing, storage and confidentiality. In this study, the interview data was handled only for the purpose of the thesis. The results are reported in a way that prevents the case company, case unit and individual participants from being recognised. This was important ethically and practically, because participants needed to be able to speak openly about visibility barriers without risking personal or organisational exposure.

5 Conclusions

This part summarises the findings and answers the research question. It also presents recommendations for the case company and suggests directions for future research. This chapter brings together the theoretical and empirical parts of the study and to show what was learned from the case. First the main findings related to supply chain visibility barriers and supporting organisational practices are summarised. After this, the research question is answered. Then recommendations for the case company are given and suggestions for future studies on supply chain visibility implementation too.

5.1 Summary of Key Findings

This thesis studied the factors that hinder effective supply chain visibility implementation in a complex make to order manufacturing environment. The findings show that SCV barriers in the case company are not caused by one single issue. Instead, they are connected to supplier visibility, processes, systems, data architecture, resources, culture and management commitment.

The first key finding is that visibility toward suppliers is limited. The case unit does not have direct system access to all relevant supplier information, like supplier safety stock levels, capacity limitations or early delivery risks. This makes the unit dependent on supplier communication and reduces its ability to anticipate material shortages early.

Another key finding is that process-related issues weaken visibility. Data errors can occur when standard processes are bypassed or handled differently. Also, there is no clear standard process for communicating smaller changes, like material structure changes, production process changes or quality issues. This can lead to inconsistent information flow between functions.

The third important finding is that ERP system limitations and fragmented data reduce visibility. The ERP system was described as heavy and rigid, and the system structure does not fully work with the current production environment. Important information is also stored outside the ERP system in Excel files, emails, documents, informal communication channels or employees' personal knowledge. This makes information harder to find, compare and use for decision-making.

The fourth main finding is that resources and time pressure limit visibility development. Employees and managers often need to focus on urgent daily operational issues. As a result, data maintenance, system development and long-term visibility improvements may receive too little attention.

The fifth key finding is that culture and management commitment affect visibility. One cultural barrier is the acceptance of inaccurate or incomplete data as a normal part of daily work. Also, many visibility problems are cross-functional and structural, so they require management level prioritisation, clear metrics, routines and follow up.

The study identified several practices that support SCV in the case company. These include clear responsibilities for correcting data errors, the use of resources like interns, active communication between functions, trust, cooperation and a positive attitude toward improvement. These practices help the unit manage visibility problems in daily work.The findings show that supply chain visibility is a technical and organisational issue. Better SCV requires reliable data and suitable systems but also clear processes, data ownership, employee competence, cross functional cooperation and management participation.

5.2 Answer to research Question

The research question of this thesis was:

What factors hinder effective supply chain visibility implementation in a complex make to order manufacturing environment?

Based on the empirical findings, effective supply chain visibility implementation is hindered by several connected factors. The main barriers identified in the case company were limited supplier visibility, process related issues, ERP system and data architecture limitations, fragmented information, resource limitations, cultural acceptance of inaccurate data and limited management level prioritisation of data quality and visibility.

The first important barrier is limited visibility toward suppliers. The case unit does not have direct system access to all relevant supplier information, like supplier safety stock levels, capacity limitations or early delivery risks. This makes the unit dependent on supplier communication and limits its ability to anticipate material shortages early enough.

Another barrier is related to processes. When standard processes are bypassed or handled differently, data errors can occur and the system may no longer reflect the real operational situation. The lack of a clear process for communicating smaller changes creates uncertainty of who receives important information and when.

The third barrier is connected to systems and data architecture. The ERP system was described as heavy and rigid, and the system structure does not fully support the current production environment. Important information is also stored outside the ERP system in Excel files, emails, documents, informal communication channels or personal knowledge. This makes visibility dependent on individuals instead of shared and reliable systems.

The fourth barrier is resource pressure. High workload, urgency and production growth reduce the time available for data maintenance, system development and long-term visibility improvement. As a result, employees and managers often need to prioritise immediate operational problems instead of systematic visibility development.

The fifth barrier is cultural and managerial. If inaccurate or incomplete data is accepted as normal, there may be less pressure to correct root causes. Also, many visibility problems are cross-functional and cannot be solved by one team alone. So, stronger management involvement is needed to define priorities, create routines, monitor data quality and give more resources for visibility improvement.

So, all in all, the research question can be answered by stating that SCV implementation is hindered by a combination of technical, process-related organisational and interorganisational factors. In a complex make-to-order manufacturing environment, these barriers are especially important because material availability, supplier reliability, production planning and customer communication are well connected. Improving supply chain visibility requires clearer processes, reliable data, supplier information, employee competence, sufficient resources and management commitment.

5.3 Recommendations for the Case Company

Based on the findings of this thesis, the case company should improve supply chain visibility through system development and organisational process development. The results show that visibility problems are not caused by one single issue. Instead, they are connected to supplier information, ERP system limitations, fragmented data, process deviations, unclear change communication, employee competence and management prioritisation. Therefore, the recommendations focus on improving the availability, reliability and usability of supply chain information across the case unit.

First, the company should improve visibility toward suppliers. At the moment, the case unit does not have direct automatic system-based access to important information from most suppliers. This includes information such as supplier safety stock levels, material availability, capacity limitations and early delivery risks. The company should define which supplier information is most critical for planning, production and customer communication. After this, more systematic ways to collect and update this information

should be created. This could include regular supplier reporting, shared reporting templates, supplier meetings or future digital solutions that allow more direct access to supplier data.

Second, the company should develop a clearer process for change communication. The findings show that smaller changes, such as changes in material structures, production processes, quality issues or other operational matters, are not always communicated through a standard process. Instead, information may be shared through meetings, emails, Teams messages or informal discussions. This creates a risk that some functions receive the information too late or not at all. Therefore, the company should define a clear process for communicating changes: what information must be shared, where it must be recorded, who is responsible for sharing it and which functions must receive it.

Third, the company should aim to keep all important supply chain information in the ERP system or in other clearly defined shared systems. Information should not be fragmented across Excel files, emails, separate documents, informal messages and personal knowledge. When information is stored outside the main system, it becomes harder to access, update, compare and use for decision-making. It also becomes harder to create reliable history data. The long-term goal should be that relevant information is timely, automatically updated, when possible, available to the right people and stored in a way that supports reporting and analysis.

Fourth, ERP training should be expanded. Employees usually know the ERP functions that are directly needed in their own work, but they might not understand how their actions affect other functions. Wider ERP training would help employees understand how data moves across procurement, production, logistics and customer care. This would increase cross-functional understanding and reduce unnecessary communication, because employees would be more capable of finding and interpreting information themselves. Better ERP competence would also reduce data errors and improve trust in the system.

Fifth, standard processes should be followed through the ERP system whenever possible. The findings show that deviations from standard processes can create data errors and extra manual work. When tasks are handled outside the ERP system, for example through email or informal communication, the system may no longer show the real operational situation. Standard processes should not be bypassed unless it is clearly necessary. Reducing unnecessary process deviations would improve data quality, reduce manual corrections, reduce interruptions in daily work and make supply chain information more reliable.

Sixth, the ERP system should be developed so that it better supports the current production environment. The findings show that production has developed, but the system structure has not fully developed at the same pace. The lack of efficient mass-editing tools in different functions causes delays, manual work and possible data errors. This weakens visibility for several teams. The company should identify the ERP functions that currently create the most manual work and prioritise improvements that would make data maintenance faster and more reliable. This could include better mass-editing tools, improved integrations, clearer reporting and better alignment between the ERP system and current production needs.

Management involvement is needed to support all these recommendations. Many visibility problems are cross-functional, which means that they cannot be solved by one team alone. Management should make supply chain visibility a clear priority, allocate enough time and resources for improvement work and follow up progress through clear routines and metrics. Without management-level prioritisation, visibility development may remain fragmented and dependent on individual effort. With stronger management support, the case company can develop SCV in a more systematic and sustainable way.

5.4 Suggestions for Future Research

Future research should continue this topic by developing a multiple case study approach. This thesis was based on one case company and one case unit, which made it possible to study the topic in depth. The findings cannot be statistically generalised to all manufacturing companies. Future studies should then examine several similar companies or manufacturing units to see whether the same SCV barrier categories appear in other contexts. These categories include limited supplier visibility, process related barriers, systems and data architecture, resources, culture and top management commitment.

A multiple-case approach would support stronger theory development. According to Eisenhardt (1989, p. 537), theoretical sampling is different from statistical sampling. Cases are not selected randomly to represent a population. Instead, they are selected because they can help reproduce, extend or challenge the emerging theory. Then future research should select cases that are theoretically useful, including companies operating in complex make to order manufacturing environments, companies with known SCV issues or companies that have strong resources but still struggle to improve visibility.

Future research should also continue adding cases until theoretical saturation is reached. Eisenhardt (1989, p. 545) explains that theoretical saturation is reached when additional cases no longer provide important new insights to the emerging theory. This means that future studies should continue collecting data until the main barrier categories become stable and well understood.

Another important suggestion is to reshape the research question more clearly toward a “how” or “why” format as seen in Table 14. Yin (2018, p. 33) states that case study research is especially suitable when the research question asks “how” or “why”, when the researcher has little control over events and when the study focuses on a contemporary phenomenon. A possible future research question could be:

Why does a company with strong resources still struggle with SCV implementation?

This question would create a more specific and theoretically interesting direction. It would ask why these barriers continue even when the organisation recognises the problem and has the resources to solve it. This could help future research move beyond general barrier identification and toward a deeper explanation of why SCV implementation remains difficult in practice.

Table 14. Relevant Situations for Different Research Methods. (Yin, 2018, p. 43).

Method	(a) Form of Research Question	(b) Requires Control Over Behavioral Events?	(c) Focuses on Contemporary Events?
Experiment	how, why?	yes	yes
Survey	who, what, where, how many, how much?	no	yes
Archival Analysis	who, what, where, how many, how much?	no	yes/no
History	how, why?	no	no
Case Study	how, why?	no	yes

Future studies should also focus especially on complex make-to-order manufacturing environments. In MTO production, customer demands, material availability, prioritisation, production capacity and delivery promises can change continuously. This makes SCV especially important, because the company needs accurate and timely information to manage uncertainty. Compared with mass production, MTO environments may create stronger visibility requirements and more complex visibility barriers.

One possible continuation of this study would be to examine the information systems perspective in more detail. This thesis identified several ERP related and data architecture-related barriers, but these issues were not studied as the main focus. Future research could investigate how ERP systems, system integrations, reporting tools, data governance and user competence affect SCV. This could provide a deeper understanding of the technical and organisational conditions that support/limit visibility development.

Future studies could also use more than one data collection method. Eisenhardt (1989, p. 538) notes that theory building case research often combines multiple data collection methods. Future research could include observations, document analysis, system data, workshops, process mapping or data quality audits. This would make it possible to compare what employees say in interviews with how systems and processes work in practice.

When more data is collected, future research should also consider using computer assisted qualitative data analysis software. In this thesis, the analysis was conducted manually, which was suitable for a small interview dataset. If future studies include several companies, more interviews and multiple data sources, software analysis would be more practical and systematic. Tools like ATLAS.ti, NVivo, HyperRESEARCH or The Ethnograph can support coding, data organisation and comparison across cases (Yin, 2018, p. 179). Software would not replace researcher interpretation, but it could improve transparency and make it easier to manage a larger amount of qualitative data.

Future researchers could build a shared research database for SCV case studies. Such a database could include anonymised case descriptions, interview frameworks, coding structures, identified barriers organisational practices and preliminary propositions from several manufacturing companies. Over time, this could help researchers compare findings across many cases and develop stronger theory about SCV implementation. Instead of treating each case study as a separate project, future research could build a cumulative empirical foundation for understanding why supply chain visibility remains difficult to implement, even when the need for improvement is recognised.

References

Agrawal, T., Kalaiarasan, R., Olhager, J. & Wiktorsson, M. (2022). Supply chain visibility: A Delphi study on managerial perspectives and priorities. International Journal of Production Research, 62(8), 2927–2942. http://dx.doi.org/10.1080/00207543.2022.2098873

Asgari, N., Nikbakhsh, E., Hill, A., & Farahani, R. Z. (2016). Supply chain management 1982–2015: A review. IMA Journal of Management Mathematics, 27(3), 353–379. https://doi.org/10.1093/imaman/dpw004

Barratt, M. & Oke, A. (2007). Antecedents of Supply Chain Visibility in Retail Supply Chains: A Resource-Based Theory Perspective. Journal of Operations Management. 25. 1217-1233. https://doi.org/10.1016/j.jom.2007.01.003

Bastas, A. & Liyanage, K. (2021). Assessing the enablers and barriers to quality and supply chain management based approach to sustainable operations in the manufacturing context. In Advances in Manufacturing Technology XXXIV: Proceedings of the 18th International Conference on Manufacturing Research, incorporating the 35th National Conference on Manufacturing Research (p. 330–337). IOS Press. 330-337. https://doi.org/10.3233/ATDE210057

Bechtel, C. & J. Jayaram (1997). Supply chain management: A strategic perspective. The International Journal of Logistics Management 8(1), 15–34. https://doi.org/10.1108/09574099710805565

Blanchard, D. (2010). Supply chain management best practices (2nd ed.). John Wiley & Sons, 18–22. https://doi.org/10.1002/9781119202912

Brandon-Jones, E., Squire, B., Autry, C. W., & Petersen, K. J. (2014). A contingent resource-based perspective of supply chain resilience and robustness. Journal of Supply Chain Management, 50(3), 55–73. https://doi.org/10.1111/jscm.12050

Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. Journal of Operations Management, 29(3), 163–180. https://doi.org/10.1016/j.jom.2010.12.008

Caridi, M., Moretto, A., Perego, A. & Tumino, A. (2014). The benefits of supply chain visibility: A value assessment model. International Journal of Production Economics, 151, 1–19. https://doi.org/10.1016/j.ijpe.2013.12.025

Carter, C. R., Rogers, D. S., & Choi, T. Y. (2015). Toward the theory of the supply chain. Journal of Supply Chain Management, 51(2), 89–97. https://doi.org/10.1111/jscm.12073

Christopher, M. (2011). Logistics & supply chain management: Creating value-adding networks (4th ed.). Financial Times Prentice Hall.

Cooper, M.C., Lambert, D.M. & Pagh, J.D. (1997). Supply chain management: More than a new name for logistics. The International Journal of Logistics Management 8(1), 1–14. https://doi.org/10.1108/09574099710805556

Corley, K. G., & Gioia, D. A. (2011). Building theory about theory building: What constitutes a theoretical contribution? Academy of Management Review, 36(1), 12–32. https://doi.org/10.5465/amr.2009.0486

Delgado, F., Garrido, S., & Beserra, B. S. (2025). Barriers to Visibility in Supply Chains: Challenges and Opportunities of Artificial Intelligence Driven by Industry 4.0 Technologies. Sustainability, 17(7), 2998. https://doi.org/10.3390/su17072998

Dubois, A., & Gadde, L.-E. (2002). Systematic combining: An abductive approach to case research. Journal of Business Research, 55(7), 553–560. https://doi.org/10.1016/S0148-2963(00)00195-8

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. Academy of Management Review, 32(4), 1155–1179. https://doi.org/10.5465/amr.2007.26586086

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. The Academy of Management Review, 14(4), 532–550. https://doi.org/10.2307/258557

Finnish National Board on Research Integrity. (2023). The Finnish code of conduct for research integrity and procedures for handling alleged violations of research integrity in Finland 2023. Finnish National Board on Research Integrity TENK. Retrieved 2026-15-04 from https://tenk.fi/sites/default/files/2023-05/RI_Guidelines_2023.pdf

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of Operations Management, 28(1), 58–71. https://doi.org/10.1016/j.jom.2009.06.001

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative Inquiry, 12(2), 219–245. https://doi.org/10.1177/1077800405284363

Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: An international study of supply chain strategies. Journal of Operations Management, 19(2), 185–200. https://doi.org/10.1016/S0272-6963(00)00055-3

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. Field Methods, 18(1), 59–82. https://doi.org/10.1177/1525822X05279903

Handfield, R. B., & Nichols, E. L. (2002). Supply chain redesign: Transforming supply chains into integrated value systems. Financial Times Prentice Hall.

Hazen, B. T., Boone, C. A., Ezell, J. D., & Jones-Farmer, L. A. (2014). Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications. International Journal of Production Economics, 154, 72–80. https://doi.org/10.1016/j.ijpe.2014.04.018

Helo, P., Tuomi, V., Kantola, J. & Sivula, A. (2019). Quick guide for Industrial Management thesis works (University of Vaasa Reports No. 14). University of Vaasa. https://urn.fi/URN:ISBN:978-952-476-871-9

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. Social Science & Medicine, 292, 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Hsuan, J., Skjøtt-Larsen, T., Kinra, A., & Kotzab, H. (2015). Managing the Global Supply Chain. (4. ed.) Copenhagen Business School Press.

Kalaiarasan, R., Agrawal, T. K., Olhager, J., Wiktorsson, M., & Hauge, J. B. (2022). Supply chain visibility for improving inbound logistics: a design science approach. International Journal of Production Research, 61(15), 5228–5243. https://doi.org/10.1080/00207543.2022.2099321

Kalaiarasan, R., Olhager, J., Agrawal, T. K. & Wiktorsson, M. (2022). The ABCDE of supply chain visibility: A systematic literature review and framework. International Journal of Production Economics, 248, 108464. https://doi.org/10.1016/j.ijpe.2022.108464

Kauppila, O., Välikangas, K. & Majava, J. (2020). Improving supply chain transparency between a manufacturer and suppliers: A triadic case study. Management and Production Engineering Review, 11(3), 84–91. https://doi.org/10.24425/mper.2020.134935

Kembro, J., Näslund, D., & Olhager, J. (2017). Information sharing across multiple supply chain tiers: A Delphi study on antecedents. International Journal of Production Economics, 193, 77–86. https://doi.org/10.1016/j.ijpe.2017.06.032

Kembro, J., & Selviaridis, K. (2015). Exploring information sharing in the extended supply chain: An interdependence perspective. Supply Chain Management: An International Journal, 20(4), 455–470. https://doi.org/10.1108/SCM-07-2014-0252

Ketokivi, M., & Choi, T. (2014). Renaissance of case research as a scientific method. Journal of Operations Management, 32(5), 232–240. https://doi.org/10.1016/j.jom.2014.03.004

Li, S., & Lin, B. (2006). Accessing information sharing and information quality in supply chain management. Decision Support Systems, 42(3), 1641–1656. https://doi.org/10.1016/j.dss.2006.02.011

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: Guided by information power. Qualitative Health Research, 26(13), 1753–1760. https://doi.org/10.1177/1049732315617444

Mentzer, J.T. (2001). Supply Chain Management. London: Sage Publications. https://doi.org/10.1002/j.2158-1592.2001.tb00001.x

New, S. J. & Payne, P. (1995). Research frameworks in logistics: three models, seven dinners and a survey. International Journal of Physical Distribution & Logistics Management, 25(10), 60–77. https://doi.org/10.1108/09600039510147663

Porter, M.E. (1989). Competitive Advantage. New York: The Free Press.

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. MIS Quarterly, 30(2), 225–246. https://doi.org/10.2307/25148729

Siggelkow, N. (2007). Persuasion with case studies. Academy of Management Journal, 50(1), 20–24. https://doi.org/10.5465/amj.2007.24160882

Somapa S., Cools M., & Dullaert W. (2018). "Characterising supply chain visibility – a literature review". The International Journal of Logistics Management, Vol. 29 No. 1, 308–339, doi: https://doi-org.proxy.uwasa.fi/10.1108/IJLM-06-2016-0150

Swafford, P. M., Ghosh, S., & Murthy, N. (2008). Achieving supply chain agility through IT integration and flexibility. International Journal of Production Economics, 116(2), 288–297. https://doi.org/10.1016/j.ijpe.2008.09.002

Swink, M., Sant'Ana, G. I., Defee, C. & da Silva, A. L. (2024). Supply chain visibility types and contextual characteristics: A literature-based synthesis. Journal of Business Logistics, 45(1), 1–29. https://doi-org.proxy.uwasa.fi/10.1111/jbl.12366

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. Qualitative Inquiry, 16(10), 837–851. https://doi.org/10.1177/1077800410383121

Vaughan, D. (1992). Theory elaboration: The heuristics of case analysis. What is a case? Exploring the foundations of social inquiry, 173–202. Cambridge University Press.

Whetten, D. A. (1989). What constitutes a theoretical contribution? Academy of Management Review, 14(4), 490–495. https://doi.org/10.5465/amr.1989.4308371

Wieland, A. (2021). Dancing the supply chain: Toward transformative supply chain management. Journal of Supply Chain Management, 57(1), 58–73. https://doi.org/10.1111/jscm.12248

Williams, B. D., Roh, J., Tokar, T. & Swink, M. (2013). Leveraging supply chain visibility for responsiveness: The moderating role of internal integration. Journal of Operations Management, 31(7–8), 543–554. https://doi.org/10.1016/j.jom.2013.09.003

Williams, M. & Moser, T. (2019). The art of coding and thematic exploration in qualitative research. International Management Review, 15(1), 45–55. https://www.imrjournal.org/uploads/1/4/2/8/14286482/imr-v15n1art4.pdf

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE Publications.

Zhang, N., He, W. & Lee, E. W. (2008). Address supply chain visibility from knowledge management perspective. In 2008 6th IEEE International Conference on Industrial Informatics, 865–870. IEEE. https://doi.org/10.1109/INDIN.2008.4618222

Zhao, X., Huo, B., Selen, W., & Yeung, J. H. Y. (2011). The impact of internal integration and relationship commitment on external integration. Journal of Operations Management, 29(1–2), 17–32. https://doi.org/10.1016/j.jom.2010.04.004

Appendices

Appendix 1. Research Permit Application

Roosa Perälä

Puh. 040 831 3028

Email: x1187925@student.uwasa.fi

RESEARCH PERMIT APPLICATION

23.3.2026

xxxxx xxxxxx

xxxxxxxxxxxxxxx

RESEARCH PERMIT APPLICATION

I am applying for research permission for a study that I intend to conduct at xxxxxxx xxxx. The subject of the research is the factors that hinder effective supply chain visibility implementation in a complex manufacturing environment. My intention is to collect information and experiences primarily through interviews with people whose daily work is greatly affected by supply chain visibility, and to use this data as material for my research.

The background information of the interviewees will be kept confidential, and individual persons will not be identifiable from the reports. In addition, the company and the specific unit under study will also be kept confidential in the published research. Participation in the interviews is entirely voluntary.

I am a Master's student at the University of Vaasa, and this research is part of my Master's thesis.

Yours sincerely,
Roosa Perälä

Appendix 2. Cover Letter

Dear Participant,

I would like to invite you to participate in a Master's thesis study on Supply Chain Visibility and its inhibitors. The purpose of this study is to identify and document the enablers and barriers affecting supply chain visibility in complex manufacturing environments. Existing research on these factors remains limited, and previous studies have highlighted the need for further empirical case-based research on the topic.

The data for this study will be collected through structured interviews with employees whose work is significantly influenced by supply chain visibility within one unit of the case company. The interview will take approximately 45 minutes.

Your privacy will be carefully protected throughout the research process. Your name and any directly identifying personal data will not be collected or stored. Interview transcripts will not be published; only the research findings will be reported in the thesis. The published findings will not contain any information that could make individual participants identifiable. The identity of the case company and the specific unit under study will also be anonymised in the thesis and will not be disclosed in the published report. Interview transcriptions will be permanently deleted within nine months after the interview. The data will be used solely for the purposes of this Master's thesis. All data will be handled confidentially, stored securely, and will not be disclosed to external parties.

Participation in this study is entirely voluntary, and you may withdraw from the study at any time without providing a reason and without any negative consequences. Whether or not you choose to participate will also remain confidential. The study is conducted at the University of Vaasa and is not funded by any external party. In accordance with university guidelines, the completed thesis will be published online.

Yours,

Roosa Perälä

Industrial Systems Analytics, Master of Science in Technology -student

University of Vaasa

Appendix 3. Interview Framework in English

Opening statement:

The interview will be transcribed using the Teams transcription tool for the purpose of analysing the research data. The transcript will not be published as such; only the research findings will be presented in the thesis. The interviewee's name, job title, company name, and any other identifiable information will be fully anonymised. In the report, the organisation will be referred to only as the case company. During the interview, you may use real names and mention the company or unit by name, as all identifiable information will be removed or modified into a secure and anonymised form during the data processing stage.

Have you read the interview information letter? (If not, go through it together before the interview.)

This research examines how visibility is realised in this unit. More specifically, I am looking at how well information is available across different stages of the supply chain, where visibility works well, where there are shortcomings, what factors support or hinder visibility, and what development needs are related to it.

The aim is to gather practical insights from the perspective of the interviewee and their team. You may take your time to consider your answers and respond as comprehensively as possible. I also ask you to answer in a way that someone from outside the unit would be able to understand the topics being discussed.

Warm-up questions:

What is your current job role, and what types of tasks does your typical working day consist of?

How would you describe your own role as part of the supply chain?

What are your key responsibilities from the perspective of supply chain operations?

Access to information in general:

What kind of information do you or your team need to perform your work as well as possible? Please list the key types of information.

Are there situations in your or your team's work where you do not receive the information you need at all, or not early enough? Could you describe an example of such a situation? What information was missing, where should the information have come from, and what were the consequences of the missing or delayed information?

What factors typically contribute to the required information not being communicated on time?

Sources of information:

From which different sources do you or your team obtain the information needed for your work? Please list them.

What kinds of unreliable, outdated, or incomplete information exist in the unit's main system?

Why do you consider this information to be unreliable or outdated?

What kind of reliable and up-to-date information do you receive directly from the system?

What kind of information do you or your team have to obtain manually, for example by calling, messaging, or asking someone face-to-face? Do you often have to wait for responses related to manually obtained information?

Systems:

Does your team use any system that is connected to the unit's main system? Does the connection work completely without errors? Please elaborate.

Do you or your team modify data in the system as part of your work? If yes, what kind of data do you modify?

How effortless and efficient do you find maintaining information in the system?

Does the ease or difficulty of maintaining information affect how often you update data and whether the information remains up to date?

Do you or your team have enough time to maintain data in the system, or is data updating sometimes left incomplete due to time pressure?

How confident are you, in general, that the information you enter into the system is correct? Is the information entered into the system sometimes based on uncertain estimates?

Are there any system functionalities or practices that make it sometimes appropriate to enter incorrect or unrealistic information into the system?

Collaboration:

What additional information would you need from procurement, production, customer service, or logistics? (Ask about the three teams that are not the interviewee's own team. This will therefore form three separate questions.)

Improvements:

What positive changes have recently occurred in visibility? In other words, has visibility improved over the years? Please elaborate.

Has there been discussion within the unit about supply chain visibility as well as data quality and accuracy? What kind of discussion has taken place? You may describe this in more detail using examples.

Is there currently any ongoing project aimed at improving visibility?

Management and prioritisation:

Do you believe that management has a clear overall understanding of the problem areas related to supply chain visibility, their root causes, and their effects on the unit's daily work?

In your view, what is the unit's most important priority now? Does this priority affect how development initiatives related to supply chain visibility or data quality progress?

Culture and responsibilities:

How does the unit respond to the fact that incorrect or incomplete information exists in the systems? Is incorrect data considered an accepted part of the current way of working or the unit's organisational culture?

Have clear responsible persons been assigned for the different data points in the system?

Closing questions:

In your opinion, what is the single biggest obstacle to visibility in the unit?

What is the root cause of this problem?

Have any actions been planned or are any actions currently ongoing to solve it?

Is there anything else that affects your work but has not yet come up, or is there anything else you would like to mention?

Appendix 4. Interview Framework in Finnish

Aloituspuhe:

Haastattelu litteroidaan Teamsin litterointityökalulla tutkimusaineiston analyysia varten. Litterointia ei julkaista sellaisenaan, vaan opinnäytetyössä esitetään ainoastaan tutkimuksen tulokset. Haastateltavan nimi, työtehtävä, yrityksen nimi sekä muut tunnistettavat tiedot anonymisoidaan kokonaisuudessaan. Raportissa organisaatioon viitataan ainoastaan case-yrityksenä. Haastattelun aikana voit kuitenkin käyttää oikeita nimiä ja mainita yrityksen tai yksikön nimen, sillä kaikki tunnistettavat tiedot poistetaan tai muokataan tietoturvalliseen ja anonymisoituun muotoon aineiston käsittelyn yhteydessä.

Oletko lukenut haastattelun saatekirjeen? (Jos ei, niin käykää yhdessä läpi ennen haastattelua)

Tutkimukseni käsittelee näkyvyyden toteutumista tässä yksikössä. Tarkastelen erityisesti sitä, kuinka hyvin tietoa on saatavilla toimitusketjun eri vaiheista, missä näkyvyys toteutuu hyvin, missä siinä esiintyy puutteita, mitkä tekijät edistävät tai estävät näkyvyyden toteutumista sekä millaisia kehityskohteita siihen liittyy.

Tavoitteena on saada käytännönläheistä tietoa haastateltavan ja hänen tiiminsä näkökulmasta. Voit pohtia vastauksiasi rauhassa ja vastata kysymyksiin mahdollisimman kattavasti. Pyydän myös vastaamaan siten, että yksikön ulkopuolinen henkilö voisi ymmärtää käsiteltävät asiat.

Lämmittelykysymykset:

Mikä on nykyinen työtehtäväsi, ja millaisista tehtävistä tyypillinen työpäiväsi koostuu?

Miten kuvailisit omaa rooliasi osana toimitusketjua?

Mitkä ovat keskeisimmät vastuusi toimitusketjun toiminnan näkökulmasta?

Tiedonsaanti yleisesti:

Millaista tietoa sinä (tai tiimisi) tarvitsee työtehtäviesi suorittamiseksi mahdollisimman hyvin? Luettele.

Esiintyykö sinun (tai tiimisi) työssä tilanteita, joissa et saa tarvitsemaasi tietoa ollenkaan tai riittävän ajoissa?

Voisitko kuvata esimerkin tällaisesta tilanteesta? Mitä tietoa tilanteessa puuttui, mistä tiedon olisi pitänyt tulla ja millaisia seurauksia tiedon puuttumisella tai viivästymisellä oli?

Mitkä tekijät tyypillisesti vaikuttavat siihen, ettei tarvittava tieto välity ajoissa?

Tiedonlähteet:

Mistä eri tietolähteistä sinä (tai tiimisi) saa työssä tarvittavaa tietoa? Listaa.

Millaisia epäluotettavia, vanhentuneita tai puutteellisia tietoja yksikön pääasiallisessa järjestelmässä esiintyy?

Mistä syistä arvioit kyseisen tiedon olevan epäluotettavaa tai vanhentunutta?

Millaista luotettavaa ja ajantasaista tietoa saat suoraan järjestelmästä?

Millaista tietoa sinä (tai tiimisi) joudut hankkimaan manuaalisesti esimerkiksi soittamalla, viestittelemällä tai kysymällä kasvotusten? Joudutko usein odottamaan vastausta manuaalisesti hankittavaan tietoon liittyen?

Järjestelmäpuoli:

Onko tiimilläsi käytössä jotain yksikön pääjärjestelmään liitettyä järjestelmää? Toimiiko yhteys täysin virheettömästi? Kerro lisää.

Muokkaatko sinä (tai tiimisi) järjestelmässä olevaa dataa osana työtehtäviänne? Jos kyllä, millaista dataa muokkaatte?

Kuinka vaivattomaksi ja tehokkaaksi koet järjestelmässä olevan tiedon ylläpitämisen?

Vaikuttaako tiedon ylläpidon vaivattomuus tai työläys siihen, kuinka usein päivität tietoja ja siihen pysyykö tieto ajan tasalla?

Onko sinulla tai tiimilläsi riittävästi aikaa järjestelmän tietojen ylläpitämiseen, vai jääkö tiedon päivittäminen kiireen vuoksi toisinaan puutteelliseksi?

Kuinka varma olet pääsääntöisesti järjestelmään syöttämäsi tiedon oikeellisuudesta? Perustuuko järjestelmään syötettävä tieto joissakin tilanteissa epävarmoihin arvioihin?

Onko järjestelmässä toiminnallisuuksia tai käytäntöjä, joiden vuoksi järjestelmään on joskus tarkoituksenmukaista syöttää väärää tai epätodellista tietoa.

Yhteistyö:

Mitä tietoa tarvitsisit lisää hankinnalta/tuotannolta/asiakaspalvelulta/logistiikalta? (Kysy ne kolme tiimiä, jotka eivät ole haastateltavan oma tiimi. Muodostuu siis kolme erillistä kysymystä.)

Parannukset:

Mitä positiivisia muutoksia näkyvyydessä on tapahtunut lähiaikoina, eli onko näkyvyys parantunut vuosien varrella? Kerro lisää.

Onko yksikössä käyty keskustelua toimitusketjun näkyvyydestä sekä datan laadusta ja oikeellisuudesta? Millaista keskustelua aiheesta on käyty? Voit kuvata asiaa tarkemmin esimerkkien avulla.

Onko parhaillaan meneillään jotakin näkyvyyden parannusprojektia?

Johto, priorisointi:

Uskotko, että johdolla on selkeä kokonaiskuva toimitusketjun näkyvyyteen liittyvistä ongelmakohdista, niiden juurisyistä sekä vaikutuksista yksikön päivittäiseen työhön?

Mikä on näkemyksesi mukaan yksikön tärkein prioriteetti tällä hetkellä? Vaikuttaako tämä prioriteetti siihen, miten toimitusketjun näkyvyyden tai datan laadun parantamiseen liittyvät kehityshankkeet etenevät?

Kulttuuri, vastuut:

Miten yksikössä suhtaudutaan siihen, että järjestelmissä esiintyy virheellistä tai puutteellista tietoa? Koetaanko virheellinen data hyväksyttävänä osana nykyistä toimintatapaa tai yksikön toimintakulttuuria?

Onko järjestelmän eri datapisteille määritelty selkeät vastuuhenkilöt?

Lopetus:

Mikä on mielestäsi suurin yksittäinen näkyvyyden este yksikössä?

Mikä on sen ongelman juuri syy?

Onko se ratkaisemiseksi suunniteltu toimia tai meneillään toimia?

Onko jotain muuta mikä vaikuttaa siun työhön mutta ei ole tullut vielä esiin, tai onko jotain mitä haluaisit vielä tuoda esiin?