UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master's Degree Project in International Business and Trade

Blockchain, the New Driver in the Automotive Global Supply Chains?

- A multiple case study of the blockchain implementation barriers in the automotive industry

Ida Söderlund & Josefin Dahlbäck

Graduate School
Master of Science in International Business and Trade
Supervisor: Mikael Hilmersson

Blockchain, the New Driver in the Automotive Global Supply Chains?
- A multiple case study of the blockchain implementation barriers in the automotive industry

By Ida Söderlund and Josefin Dahlbäck

Institute of International Business and Trade
School of Business, Economics and Law, University of Gothenburg,
Vasagatan 1, P.O. Box 600, SE 405 30
Gothenburg, Sweden

Contact: IdaSoderlund@hotmail.com; Josefin_Dahlback@hotmail.com

Abstract
Large multinational companies (MNCs) with complex global supply chains face increasing challenges with unsustainable supply chains, both regarding strategy and stakeholder pressure. A potentially revolutionizing new tecgenhnology, blockchain, has just started being used to cope with these numeral global supply chain challenges. The research in this field are scarce, and as the study finds, as are the companies currently using blockchain to this end.

This study provides a contribution for theory by adding knowledge to the research fields of blockchain and to the governance of global supply chains that is not in direct control by the MNC, related to the implementation of new technology. This is done by examining what barriers exist to implementing blockchain in global supply chains for MNCs in the automotive industry, with the goal to increase supply chain transparency. By using an exploratory multiple case study approach, including qualitative, semi-structured interviews with six automotive MNCs, complemented by four interviews with blockchain experts, the authors developed propositions of the interconnectedness between MNCs and their global supply chain governance related to the barriers to adopt blockchain.

Previous research shows that blockchain is suitable for supply chains. The main findings show that not enough incentives exist for automotive MNCs to implement blockchain for a transparency purpose since the MNCs' motivation and challenges are not aligned with the technology's contribution. Several difficulties with implementation were found. Also, the current governance system being employed is hampering blockchain implementation. Interestingly, the study also showed that the kind of blockchain required to solve these complex issues is not compatible with the traditionally oriented culture of the MNCs. Consequently, this study provides knowledge to both theories on blockchain and global supply chain governance as well as to business practices.

Keywords: MNCs, Global Supply Chains, Governance, Blockchain Technology, Transparency, Technology Implementation, Sustainability, Automotive Industry

Acknowledgments
We would like to thank all our contact persons at the automotive MNCs' and technology companies that helped us to reach out to the right contact persons. In particular, our sincerest gratitude goes to all the interviewees that allocated both time and effort to participate in our study and provided us with the information needed to investigate the subject. Thank you all, managers from the automotive MNCs', experts from the academia and consultant firms.

Lastly, but not least, our appreciation goes to everyone that in one way or another has contributed to this study from the School of Business, Economics and Law, Gothenburg University. In particular, we would like to thank Mikael Hilmersson for valuable feedback and guidance throughout the process. We are truly grateful for your expertise and input.

Gothenburg, 5th of June 2020

Ida Söderlund

Josefin Dahlbäck

TABLE OF CONTENT

List of Figures

List of Tables

1 Introduction

This chapter starts with a description of a use case of the thesis topic, which is followed by the background and the problem of the subject the thesis will investigate. Subsequent to the problem discussion that this thesis is built upon, the purpose, the research question, a description of the study delimitations, and disposition will follow.

1.1 Implementation of Blockchain

Blockchain was used by Walmart in 2017 with the purpose to solve social problems in global supply chain management (Kamath, 2018). Walmart is a multinational company (henceforth referred to as MNC) with an extensive product portfolio filled with multi-ingredient components from multiple countries, thus highly embedded in complex global supply chains. It is essential for Walmart to ensure transparency across the food supply chain due to the need to take quick action if any food product is the source of a disease outbreak (ibid). The purpose of implementing blockchain technology in Walmart's global supply chain was to track individual product location of origin and to secure the correctness of information provided (Kamath, 2018; Tan, Yan, Chen and Liu, 2018). The solution to digitize global trade patterns through the blockchain technology has for Walmart increased transparency and traceability, as the time for tracking physical products within the supply chain was reduced from seven days to 2.2 seconds. This has been useful as it enables the tracking of diseases caused by a certain batch of food and allows Walmart to take faster action and remedy arising issues (Kamath, 2018). The technology provided instant information that is otherwise very difficult to obtain and also alter human interference, implying that information stored in blockchain has less risk of being faulty or manipulated. For example, information is entered into the blockchain instead of being written on paper and transferred between parties (Tan et al, 2018). Subsequently, the blockchain technology ensured Walmart end-to-end traceability through a data record following the product from the farm to the consumer. Due to traceability possibilities, it increased safety by enabling faster contamination investigations and increased public confidence through Walmart's enhanced accountability (Kamath, 2018). To conclude, the blockchain technology-enabled traceability, which has enhanced transparency in Walmart's global supply chain, influenced both the company and its ability to select suppliers based on their sustainability performance (Tan et al., 2018).

This case is one of few well-documented blockchain use cases and exemplifies the implementation of blockchain in the food industry regarding traceability and transparency. This study's focus is instead on the automotive industry, which is a sector facing several supply chain risks due to globalized, fragmented and very complex supply chains (Thun and Hoenig, 2011), implying a great challenge regarding supply chain transparency (Yong-Shin et al., 2018). However, there is no use case of blockchain and no research on blockchain in the automotive sector specifically. Therefore, the Walmart case gives examples of what a blockchain implementation could achieve and has spawned the interest to investigate why blockchain technology has not been used in the automotive industry.

1.2 MNCs and Global Supply Chains

Organizations are increasingly incorporating holistic sustainability strategies into their operations and decision-making in order to mitigate global sustainability challenges (Chen, 2018). Large MNCs are being targeted by the United Nations (UN) to incorporate sustainability into their strategies due to their significant global and local impact, (Huq and Stevenson, 2020; UN Global Compact, n.d). Previously, due to governmental regulatory pressure, business strategies have been addressing the environmental sustainability challenges (Carter and Rogers, 2008; Huq, Stevenson, Zorzini., 2014, Gold and Schepler, 2017), resulting in an emphasis on climate change mitigation (Zorzini, Hendry, Huq and Stevenson, 2015; Mani, Gunasekaran, Papadopoulos, Hazen, and Dubey, 2016). On the other hand, social sustainability is entailing health and safety issues, child and bonded labor, living conditions, pay inequities, and level of wages (Hutchins and Sutherland, 2008; Mani, Agrawal, and Sharma., 2015). This means that social sustainability is principal and arguably equivalent in terms of economic benefits (Marshall, McCarthy, Claudy and McGrath, P., 2019), although of a more dynamic, abstract and complex nature, which is hard to measure and navigate as this often occur upstream the supply chain (Mani et al., 2015; Mani, Gunasekaran and Delgado., 2018; Miemczyk and Luzzini, 2019; Huq and Stevenson, 2020). However, this is important for MNCs due to their large sphere of influence on societies both directly and indirectly (Chen, 2018; OECD, 2019). Nevertheless, many MNCs express the lack of knowledge of how to address social sustainability concerns (Huq et al., 2014), especially when having complex global supply chains (Mani et al., 2015).

Companies are to an increasing extent held responsible for the entire global supply chain as a result of an increased focus on sustainable supply chain management (Bentahar and Benzidia, 2018). The notion of sustainable supply chain management covers supplier development, sustainability reporting, power imbalances, decision-making, socially sustainable supply chains, supply chain risk management, and multi-tier supply chains, hence operating without harming social systems or nature while conducting profitable business (Gold and Schepler, 2017). Large scale intra- and inter-organizational flow of goods between nations in both vertical and horizontal global supply chains have created both opportunities and challenges for MNCs (Tannous and Yoon, 2018). It has been debated to what extent companies should be held responsible for their upstream suppliers (Chen, 2018). However, the trend is increasingly moving towards greater scrutiny for MNCs in terms of customer and legislative pressure regarding their involvement globally, (Grimm et al., 2014; Leire and Mont, 2010; Miemszyk and Luzzini, 2019) and misconduct in upstream supply chains are often revealed in media (Mani et al., 2015). Consequently, companies are required to become transparent, meaning that supply chain information sharing is essential (Bai and Sarkis, 2020).

The importance of MNCs' ability to trace the global supply chain has also increased due to the need to mitigate risks and changes in sources of supply (UNCTAD, 2020). Accordingly, in order to remain competitive, it is vital to involve suppliers and sub-suppliers (Nassar, Kandil, Er Kara and Ghadge, 2019). This means that traceability, knowing which the suppliers and sub-suppliers are and what components they produce, is a key factor to increase sustainable global

supply chain management and transparency (Cole, Stevenson and Aitken., 2019; Harvard Business Review, HBR, 2019; Marshall et al., 2019). HBR, (2017) published results indicating that 80% of the companies surveyed did not know the country of origin of the raw material used in the products, especially companies that have a high degree of global outsourcing and a high degree of global sales. The outbreak of the disease COVID-19 is highlighting the real risk of disrupted global value chains. It has caused extensive crises and severely affected MNCs due to production shortage, particularly in China (Weforum, 2020), as a result of MNCs' unawareness of their indirect suppliers (HBR, 2020). This may lead to a significant negative impact, thus resulting in a financial and reputational loss (Thun and Hoenig, 2011). Subsequently, the traditional notion of supply chain management including cost, time, and quality (Bentahar and Benzidia, 2018) has been further developed and the dimensions have broadened towards a more inclusive sustainable multi-tier approach (Moktadir et al., 2018).

However, in order for the MNC to increase traceability and transparency for suppliers located in widely differing geographical areas, different governance modes are employed (Boström, Jönsson, Lockie, Mol and Oosterveer., 2015). It is common in sustainable supply chain management to use a code of conduct and self-assessment systems (Kshetri, 2018; UN Global Compact, n.d) implying that inter-party trust is essential. However, control, collaboration, and practices to engage and monitor suppliers are lacking, particularly in terms of sustainability compliance (Kshetri, 2018; Wong, Leong, Hew, Tan and Ooi, 2020). Accordingly, to increase global supply chain governance, new technology is argued to be a promising solution (Brockhaus, Fawcett, Knemeyer and Fawcett., 2017), where blockchain technology is argued to be useful in order to increase supply chain transparency (Kshetri, 2018; Cole et al., 2019; Hughes, Dwivedi, Misra, Rana, Raghavan and Akella., 2019; Longo, Nicoletti, Padovano, d'Atri and Forte., 2019).

As described in the use case of Walmart, *1.1 Implementation of Blockchain*, blockchain technology is promising to enhance sustainable supply chain management due to the possibility to increase traceability, leading to transparency (Kshetri, 2018; Roeck, Sternberg and Hofmann., 2019), which is likely to influence several key objectives within supply chain management (Kshetri, 2018). Since its creation, blockchain has developed from the cryptocurrency Bitcoin, towards proven to be useful for multiple areas as it recently got announced as the latest revolutionary technology (Hughes et al., 2019). In short, blockchain can ensure secure transactions through cryptographic algorithms (Biswas and Gupta, 2019; Roeck et al., 2019). Among other blockchain-enabled benefits, it is also a prominent tool to increase accountability, trust, security, efficiency, and limit behavioral uncertainty (Hughes et al., 2019; Wamba and Queiroz, 2020). Accordingly, in a supply chain, blockchain serves as a ledger to trace the origin and all steps of a component, subsequently reducing information asymmetry and enables the MNCs to take effective measures in the supply chain. Connecting blockchain with global supply chain management may reduce the risk of opportunistic behavior, reduce costs, and reduce the risk of fraud (Wong et al., 2020). Therefore, it is argued that supply chain transparency is among the most salient performance dimensions involved in the future of business, leading to increased responsibility beyond the core company (Kshetri, 2018; Bai and Sarkis, 2020).

1.3 Problem Discussion

The more complex global supply chains the harder to ensure transparency (HBR, 2017), supplier integration (Kim and Davis, 2016) and decrease vulnerability (Thun and Hoenig, 2011). Pressures to increase intra-supply chain transparency has been evident in the fast fashion and food industries (Bettin-Diaz, Rojas and Mejia-Mancayoet, 2018; Kshetri, 2018). Lately, this has evolved to reach mainstream awareness and encompass several industries, particularly regarding social sustainability (Kshetri, 2018; Bubicz, Barbosa-Póvoa and Carvalho., 2019).

Companies involved in global value chains have boundless amounts of transactions, with hundreds of suppliers in multiple countries (Norberg, 2019), which results in a lack of knowledge of which suppliers and sub-suppliers are included in transborder supply chains (Grimm et al., 2014; Egels-Zandén, Hulthén and Wulff., 2015). Meaning that companies are facing difficulties in tracing the supply chain, therefore, an inability to collect information of sub-suppliers (Egels-Zandén et al., 2015). However, there are two facets to acquiring knowledge regarding sub-suppliers. Firstly, there is growing stakeholder pressure to ensure compliance with social sustainability concerns, for example when sourcing minerals, (HBR, 2017; Huq and Stevenson, 2020) but there is also a need to create means of preventing and mitigating risks with regards to disruptions or rapidly changing conditions in the global supply chains (HBR, 2020; UNCTAD, 2020).

The global production networks for manufacturing modern electric vehicles are causing the exploitation of natural resources (Kim and Davis, 2016). Many of the extracted minerals are called conflict minerals, which is a label concerning gold, tungsten, tin and tantalum (European Commission, 2017; HBR, 2017). This is due to their origin in areas with a high degree of conflicts, violence, lack of human rights and illegal extraction (EU Science Hub, 2020), often located in developing countries with little resources or economic and political incentives to engage in social sustainability (Huq et al., 2014). Due to the need for these minerals in the production of automotive and smart products, the issues regarding conflict minerals in regard to the automotive industry has risen, albeit lacking transparency leaves companies unknowingly using these minerals (HBR, 2017). Furthermore, companies within the automotive sector have been the most vulnerable to the COVID-19 outbreak, due to their inability to cope with the manufacturing slowdown and supply chain disruptions in many regions globally (HBR, 2020; UNCTAD, 2020). Automotive MNCs are argued to be particularly fragile as a result of their difficulties to find alternatives due to reliance on certain suppliers (Weforum, 2020). Subsequently, external shocks, such as COVID-19, interfere with their entire global supply chains (Deloitte, 2020; HBR, 2020). In addition, climate change and geopolitical tensions are argued to increase these issues in the future (Deloitte, 2020; Weforum, 2020). This creates the need for connectedness, with increased visibility in a complete supply chain network, where new technology is suggested to cope with supply chain challenges and increase companies' resistance in potential future disruptions (Deloitte, 2020).

The current supply chain governance systems leave large transparency gaps, which indicates that there is a clear insufficiency of practices to ensure reliable information (Bai and Sarkis,

2020; Rejeb et al., 2019), meaning that legislative remedies are needed (UN Global Compact, n.d). Minerals from specific exploited areas will be prohibited for imports in the EU by 2021 (European Commission, 2017). It is crucial for MNCs to reduce information asymmetry and increase trust throughout the supply chain (Villena and Gioia, 2018), as self-reporting systems allow for discrepancies between what is happening and what is reported (Bai and Sarkis, 2020). Therefore, there is a need for investment in reliable traceability systems (OECD, 2019), which enhances transparency (Ping-Kuo and Ye, 2019) in order for automotive MNCs to comply with further restrictions. Transparency includes traceability (Sodhi and Tang, 2019), thus, this broader term encompasses the prerequisite of traceability.

With regards to transparency both to cope with future disruptions, and to ensure compliance with sustainability in the extraction of raw material, technological tools have been suggested as a solution (Bubicz et al., 2019; Deloitte, 2020). Blockchain technology has great promise to enhance transparency by ensuring traceability in global supply chains (Bai and Sarkis, 2020; Schmidt and Wagner, 2019), thereby positively contributing to the automotive industry's challenges discussed above. However, although the blockchain technology provides solutions and multiple benefits within supply chain management it has limited implementation evidence and requires more research (Bai, Cordeiro and Sarkis, 2020; Hughes et al., 2019). It is argued to come with high levels of uncertainty regarding the implementation of blockchain, while also lacking industry standards (Rejeb et al., 2019; Saberi, Kouhizadeh, Sarkis and Shen., 2019). Traditional supply chain governance is focusing on the first-tier supplier (Koberg and Longoni, 2019), meaning that MNCs do not know their sub-suppliers beyond that point. However, to implement blockchain, this has to be done in the entire supply chain, from the MNC to the lowest tier (Venkatesh, Kang, Wang, Zhong and Zhang., 2020). Therefore, this raises multiple concerns regarding how this technology could be implemented despite limited visibility in the supply chain.

Given the novelty of blockchain application, there is scarce research on the use of blockchain technology for managing global supply chain transparency (Hughes et al., 2019; Venkatesh et al., 2020; Huq and Stevenson, 2020), lack empirical studies (Wamba and Queiroz, 2020) and limited practical success stories (Longo et al., 2019). Thereby, it is argued that it is suitable as a point of departure to examine what constitutes the barriers to implement blockchain for transparency purposes (Schmidt and Wagner, 2019). In addition, there is near to non-existent research on blockchain in the automotive industry, or in MNCs global supply chains, despite a vast hype surrounding the technology. This, in conjunction with the current global supply chain transparency challenges that have been discussed, implies that an increased understanding of the automotive MNCs supply chain compatibility with blockchain, and more research on what the implications for adopting the technology are, is required. It is crucial for academia and business practitioners to examine new technologies, such as blockchain, in order to enhance the understanding of its implications and how it could affect global supply chain governance, and how governance influence adoption of new technologies. Therefore, more empirical research out of an organizational perspective is needed in order to understand why blockchain technology has not been implemented within MNCs in the automotive sector to increase transparency.

1.4 Purpose and Research Question

The purpose of this study is to understand the implementation barriers of blockchain within MNCs' in the automotive industry, in order to increase transparency in their global supply chains. More specifically, the aim is to create knowledge of what the obstacles for the adoption of blockchain technology are regarding the inherent characteristics of the MNCs and their governance of a global supply chain, which is out of direct control. Subsequently, contributing to the research field of blockchain and global supply chain governance.

Based on the background and the above purpose, a research question has been formulated:

- What are the implementation barriers for the use of blockchain technology in the automotive MNCs' global supply chains to increase transparency?

1.5 Delimitations

In order for the thesis to have a clear focus, several limitations have been made. Firstly, the scope of the study is limited to transparency, although there are several challenges in global supply chains and the process towards sustainable supply chains. The findings in the literature review revealed that transparency is commonly perceived to be a key factor in sustainable supply chains and is seemingly crucial for all MNCs as it builds upon traceability and visibility. Therefore, this is used in order to create a solid comparable measure for the study. Secondly, when discussing global supply chains, the study will focus on the organizations' upstream activities and thereby exclude the downstream activities. Thirdly, the scope of the study is delimited to MNCs within the automotive industry, meaning that other industries and sectors will not be analyzed.

1.6 Disposition

The research will consist of six chapters, a reference list, and an appendix and is presented in the following order.

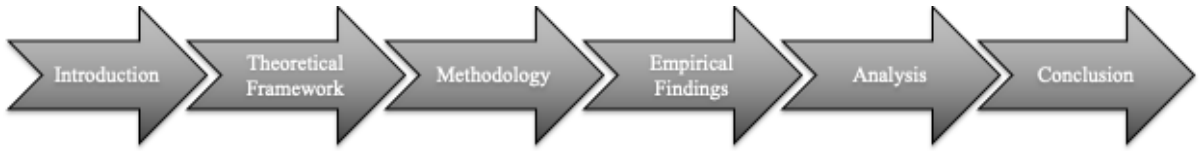

Figure 1.1: Disposition of research process. Compiled by authors.

2 Theoretical Framework

This chapter presents a theoretical framework, starting to describe the context of how the theory sections relate to each other. Followed by addressing the three main areas; MNCs driving forces in terms of global supply chains, the MNCs governance of global supply chains, followed by blockchain technology. Lastly, a conceptual framework is presented to provide a further understanding of the thesis key concepts.

2.1 The Theoretical Context

MNCs today are highly embedded into global supply chains due to their strategies to outsource or offshore production networks on a global scale to increase profitability (Aydin, Cattani and Druehl, 2014; Chaudhuri, Boer, and Taran., 2018). Globalized production and the use of global supply chains are decoupling the organization, while simultaneously requiring companies to internalize different societies' needs and increase collaboration to meet sustainability demands by customers, governments, society and media (Moss Kanter, 2011; Bateman, 2015; Silvestre, Monteiro, Viana and de Sousa-Filho., 2018). Therefore, MNCs are increasingly under scrutiny and need to increase their transparency to stakeholders (Mani et al., 2015; Chen, 2018; Venkatesh et al., 2020).

In order to increase transparency, companies need to increase the traceability and visibility in the supply chains (Roeck et al., 2019; Sodhi and Tang, 2019). Consequently, this poses the MNCs into a difficult situation, which requires collaboration and information sharing on a global level, despite lacking knowledge regarding suppliers (Govindan, Seuring, Zhu and Azevedo., 2016), which is a result of complex and large numbers of suppliers (Egels-Zandén, 2015). Moreover, information asymmetry is one of the main factors leading to the agency dilemma (Eisenhardt, 1989a). In order to reduce information asymmetry, supply chain governance may be increased, both in terms of formal and more informal information sharing with embedded actors to increase transparency, although currently having limited influence on information flow (Boström et al., 2015). Thus, this put forward the question regarding global supply chain governance to increase transparency.

Blockchain technology is a tool that enables increased traceability by enhanced governance, due to its capabilities to provide tamper-proof, secure, and transparent information (Roeck et al., 2019). Greater supply chain traceability, which enhance transparency, will lead to knowledge of upstream suppliers (Goldstein and Newell, 2020). Accordingly, the use of blockchain in the MNCs global supply chains increases traceability in which subsequently may increase transparency towards stakeholders (Bai and Sarkis, 2020) and meet customer demand (Silvestre et al., 2018).

To summarize, stakeholder pressure for sustainability in conjunction with the agency dilemma stemming from information asymmetry in the global supply chains creates a need for governance and are potent to drive MNCs to increase global supply chain transparency by using blockchain-enabled traceability. *Figure 2.1* below illustrates the setting around MNCs' global

supply chains. The dashed rectangle is the focus of the thesis and will be described further in this theory chapter and described in greater detail in section *2.5 Conceptual Framework*. Combining the current MNC drivers and global supply chain governance information with the aspects of blockchain will create a structure for answering the research question.

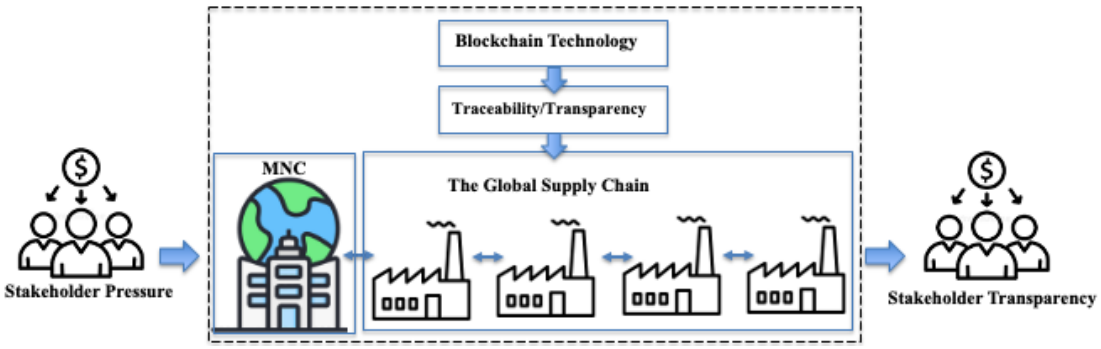

Figure 2.1: Disposition of the theoretical context. Compiled by authors.

2.2 MNCs' Driving Forces in Global Supply Chains

Global supply chain involves the organizational structure of all activities performed by different nodes in a company's network, from the extraction of raw material to final consumption, where supply chain management is the organization of the relationship between these nodes (D'Eusanio et al., 2019). The nodes may be either subsidiary to the company or external parties, implying there are intra-organizational perspectives and inter-organizational concerns within global supply chains with a direct or indirect connection to the core company (Chen, 2018). In contrast to local and regional supply chains, global supply chains are characterized by large distances, differing political environments, cultures, and values (Boström et al., 2015; Kano, 2018). The increasing allocation of supply chains on a global level implies that the complexity of supply chains and its coordination is constantly growing (Koberg and Longoni, 2019; Roeck et al., 2019). However, companies embeddedness in global supply chains might be seen as a competitive advantage, due to the possibility to optimize the geographical footprint to gain location-specific advantages (Song et al., 2018) and increase stakeholder value (Mani et al., 2018; Tannous and Yoon, 2018). Accordingly, the combination of transborder supply chain networks is determining firm performance by effective use of resources globally (Kano, 2018). Therefore, there is a larger competition on an inter-supply chain level and companies are no longer competing as autonomous entities, but entire supply chains (D'Eusanio et al., 2019; Nassar et al., 2019).

2.2.1 Motivation for Sustainability and Transparency

A company's strategic direction is underpinning the logic behind decisions and investments, which is founded in institutional grounding and it is crucial to have a long-term perspective (Moss Kanter, 2011). A company's strategic position is a result of resources and capabilities which may enhance competitive advantage (Barney, 1991). On the other hand, DiMaggio and Powell (1983) argue that organizational change, meaning changes in organizational mission, structure, goal, and culture, is not primarily driven by competition but rather institutional pressure. Consequently, institutional theories imply that firms need to be similar in order to gain legitimacy (DiMaggio and Powell, 1983), meaning that firms adapt to each other to act

similarly. Change, for example within supply chains, is argued to be stronger when firms are dependent on each other (Kitzmueller and Shimshack, 2012). However, companies are faced with paradoxical demands from different stakeholders, and needs to create socio-ecological benefits to stakeholders (Silvestre, Monteiro, Viana and de Sousa-Filho, 2018). In addition, there is an increasing stakeholder pressure to engage in activities to address sustainability (Schöggl, 2016), particularly as social sustainability concerns are growing (Leire and Mont, 2010; Miemszyk and Luzzini, 2019; Villena and Gioia, 2018; Venkatesh et al., 2020). At the same time, Jensen (2002) states that engagement in corporate social responsibility may be due to pure managerial interests that drive the investments.

Supply chain sustainability is regarded to be highly correlated to supply chain transparency, due to the need for transparent, inter-organizational integration of the organization's sustainability processes to improve all parties, including the supply chains and business performance (Carter and Rogers, 2008). Sodhi and Tang (2019) make a distinction between different aspects of transparency. In the supply chain context, transparency means the disclosure of information to stakeholders regarding upstream activities, while traceability is an aspect of visibility that means that the company is capable of ascertaining the country of origin of its products, which is often labeled provenance (Sodhi and Tang, 2019). Bateman (2015) has a similar definition but extended to encompass the ability to retrieve information regarding the materials and the products in the supply chain.

Transparency is argued to be essential to build legitimacy, to enhance corporate reputation (Roeck et al., 2019; Thun and Hoenig, 2011) and several authors refer to the effect on the brand upstream supplier knowledge and transparency may have (Baralla, Ibba, Marchesi, Tonelli and Missineo, 2018; Goldstein and Newell, 2020). Having greater supply chain transparency will lead to knowledge of upstream suppliers which could facilitate decision-making (Goldstein and Newell, 2020), decrease lower-tier risks, and regulatory compliance (Bateman, 2015). The reason for this is that information transparency on a supplier level means that information regarding the suppliers' resources is released to the actors within the supply chain (Sodhi and Tang, 2019), which is essential to a company to adjust and enable improvements of the supply chain (Shi, Chen and Ye., 2019). However, according to Kim and Davis (2016) the ability to trace the supply chain does not increase dependent on the reputation or visibility of the company, nor motivation to be voluntarily engaged in corporate social responsibility.

In order to enhance the geographical footprint, global supply chains are embedded in all MNCs strategies and allocated on dispersed areas to reap the benefits of location-specific advantages to gain competitive advantage (Song, Chen and Wang., 2018) and stakeholder value (Mani et al., 2018; Tannous and Yoon, 2018). For MNCs in global supply chains, this means that they need to be transparent due to increasing accountability for activities further upstream the supply chain (Mani et al., 2015; Chen, 2018). To succeed, companies are required to build innovation capabilities to address sustainable management of the supply chain (D'Eusanio et al., 2019).

2.2.2 Global Supply Chain Challenges

Information asymmetry

Governance of supply chains has been established as an important aspect of organizations due to challenges mostly related to the complex relationship between the units (Fayezi, O'Loughlin and Zutshi., 2012). The main challenge is to increase visibility and traceability, thus increase information flows (Sodhi and Tang, 2019). However, difficult due to the complexity to coordinate a global supply chain, as it is often out of direct control for MNCs' (ibid), in comparison to prior strategic management theories (Barney, 1991). The foundation is that there is a misalignment in interest, for example, the principle is seeking profit maximization which is conflicting with managerial interest such as salary or low work effort, causing goal congruence (Thomsen and Pedersen, 2000). The agency theory was first introduced to analyze corporate behavior in terms of the relationship between the principal (owner) and the agent (managers) (Jensen and Meckling, 1976). The dilemma is related to when the principle is delegating a task, such as outsourcing a production, however creating issues due to information asymmetry, different incentives, incomplete relationships, and gaps in observation possibilities (Eisenhardt, 1989a). Thus, this may occur when there are divergent interest and problems are having a cooperative structure, which results in information being essential in order to reduce opportunism and self-interest in a relationship (Ibid). Subsequently, in an organizational context, there are corporate behavioral consequences leading to different control mechanisms, monitoring, and governance systems (Fayezi et al., 2012; Thomsen and Pedersen, 2000).

In the supply chain, there is a challenge to align different interests of multiple independent units (Kano, 2018; Silvestre et al., 2018), thus bridging information asymmetry (Boström et al., 2015; Vosooghidizaji, Taghipour and Canel-Depitre., 2019). Behavioral uncertainty in the supply chain occurs when it is difficult to ascertain a performance post a transaction (Schmidt and Wagner, 2019). Therefore, agency theory may be used to analyze how risk, relationships, and incentives are managed in supply chains (Fayezi et al., 2012), as poor supply chain relationships may increase the risk of driving opportunistic behavior (Liu, 2018). These opportunistic behavior are exemplified by scandals often occurring further upstream supply chains regarding child and forced labor for companies such as Nike and Unilever (Villena and Gioia, 2018; Venkatesh et al., 2020), and industries related to conflict diamonds (Weygand, Rebovich, Donald and Starrett., 2019) and conflict minerals (HBR, 2017). Miemczyk and Luzzini (2019) explain that it is important to focus on risk reduction, supplier development, and collaboration to improve the global supply chain. However, the choice of governance system may be dependent on the context in which the company is engaged, and the cost of compliance (Eisenhardt, 1989a; Lu, Meng and Goh., 2014).

Transparency

The level of complexity in companies' supply chains is decreasing the degree of transparency towards stakeholders and thus the companies' possibility to rely on the information provided in the supply chains (Kim and Davis, 2016). Accordingly, the lack of visibility and traceability are negatively influencing transparency within supply chain management (Roeck et al., 2019; Sodhi and Tang, 2019). However, Carter and Rogers' (2008) earlier study show that transparency may be regarded to consist of a stakeholder dimension and a supplier dimension,

meaning that there are both internal and external aspects of transparency to the company. Although, if a company have multi-tier knowledge of the supply chain, the company could choose to disclose information regarding only their first-tier suppliers or disclose information regarding all suppliers, or no information regarding the suppliers (Sodhi and Tang, 2019). This implies that selective transparency is possibly occurring in global supply chains (Boström et al., 2015). At the same time, previous literature shows that information sharing, and transparency are necessary to reduce supply chain uncertainty (Schmidt and Wagner, 2019). Therefore, it has been suggested that in order to mitigate and reduce the agency problem, companies may use blockchain technology (Korpela et al., 2017). Similarly, Astill et al., (2019) underline the need for new technologies to establish transparency in supply chains.

2.3 Global Supply Chain Governance

Supply chain governance is important as traceability and transparency enable greater upstream knowledge (Shi et al., 2019), thus reducing information asymmetry. According to Boström et al. (2015) supply chain governance includes formal and informal practices, including policies, guidelines, laws, norms, and monitoring, as tools to decrease behavioral uncertainty (ibid), i.e uncertain environments where performance may not be verified (Rindfleisch and Heide, 1997). This is aligned with Fayez et al., (2012), meaning that both contractual and relational governance factors interplay in the governance of a supply chain, although, the execution is dependent on trust, coercive and non-coercive power (Meqdadi, Johnsen and Johnsen, 2017). In this section the foundation for having a governance system is discussed, stemming from the agency theory described above which leads to companies' need for mitigation and remedy activities. Based on Boström et al., (2015) and Fayez et al., (2012), these are divided into contractual and non-contractual remedies.

2.3.1 Contractual Governance

Monitoring activities

A monitoring system is based on a high degree of trust between parties, bargaining power within the supply chain, but also formal mechanisms, such as contractual agreements (Ghosh and Fedorowicz, 2008). When there is a non-collaborative environment surrounding the organizations, contractual and formal governance increases (Formentini and Taticchi, 2016). In global supply chains, large MNCs are increasingly held responsible for activities occurring outside the immediate borders as a result of increasing stakeholder pressure, leading to the fact that MNCs are altering the contractual remedies to decrease the geographical distance to enable monitoring, thus enhance governable global supply chains (Boström et al., 2015). Consequently, there is a movement towards less traditional supply chains also named open structures, thus altering the previous focus solely on first-tier suppliers (Koberg and Longoni, 2019) where the responsibility to influence upstream suppliers is put on the first-tier supplier (Villena and Gioia, 2018). Both business and research, focus increasingly on sub-suppliers, employing more closed structures, meaning that the MNC establish direct links with sub-supplier (Koberg and Longoni, 2019). This is exemplified by Ivarsson and Alvstam's (2009) study where the multi-tier supply chain and supplier collaboration are in focus, and this is efficiently increasing supplier sustainability compliance (Koberg and Longoni, 2009).

Furthermore, in order to reduce information asymmetry and increase compliance, companies implement labeling, auditing procedures, procurement guidelines, code of conduct, and contractual agreements (Boström et al., 2015). Cooperation and monitoring activities, such as auditing or supply chain policies are increasing transparency and simultaneously lowering the transaction costs (Carter and Rogers, 2008). Further, this improves operational decisions and enhance supply chain disclosures to stakeholders (Sodhi and Tang, 2019). However, a governance system should be designed to benefit the entire supply chain in order to be successful, not solely benefit the large MNC (Ghosh and Fedorowicz, 2008). There is no established tool or assessment system to enable fully informed decisions regarding the supply chains (D'Eusanio et al., 2019), and there are large compliance gaps although having monitoring systems in place (Boström et al., 2015). The tools used are often limited to the company's boundary of knowledge, limited to parts of the specific supply chain (D'Eusanio et al., 2019). As a first step, it is important to gather information to monitor and evaluate suppliers, meaning there is an assessment process of suppliers (Koberg and Longoni, 2019).

Evaluation of suppliers

It is essential to have mutual understanding and credibility in order to reduce opportunistic attitudes (Almeida et al., 2017). Evaluation and monitoring of activities performed on sub-suppliers are essential to decrease the likelihood of unreliable behavior as companies' underperformance is more likely to be revealed (D'Eusanio et al., 2019). Kano (2018) argues that it is the orchestrating firm, e.g. the MNC that has the power and responsibility to implement these standards in the supply chain. However, there is a paradox that companies are increasingly held accountable for their suppliers' actions while the companies' actual ability to live up to the expectations is decreasing (Kim and Davis, 2016). This is due to the challenge of being able to select and properly evaluate the supplier, but not being able to influence the sub-suppliers of that company, thus companies are being subject to bounded rationality (Kano, 2018), which is related to the agency dilemma (Eisenhardt, 1989a). In addition, short term payoff and the need to keep efficient operations may influence the ability to perform a proper screening (Kano, 2018).

Third-party governance

There is direct and indirect governance (Koberg and Longoni, 2019), also named self-managed or outsourced governance respectively (Lu et al., 2014). Direct governance means that the focal firm invests time and resources to engage in supplier governance, and indirect governance is the use of a third actor to ensure supplier compliance (Koberg and Longoni, 2019). When governing the supply chain, there is a need for a third-party actor to ensure the accuracy of the information given in supply chains (Tan et al., 2018). This further results in sustainable supply chains (Grimm et al., 2016; Liu et al., 2018). The trusted third parties are often integrated into companies' governance systems to gain information today (Korpela et al., 2017). However, using an intermediary can be argued to reduce the transparency and reliability (Korpela et al., 2017) and leave room for interpretation of the information provided (Boström et al., 2015).

2.3.2 Non-Contractual Governance

Inter-organizational collaboration

Successful global supply chain management requires inter-organizational networks to achieve a significant level of collaboration (Vosooghidizaji et al., 2019). Trust is a prominent factor that leads to greater information sharing and joint decision making (Liu, 2018; Vosooghidizaji et al., 2019). A governance system increases the inter-organizational information sharing and the quality of the information in terms of frequency and the accuracy of the data (Ghosh and Fedorowicz, 2008). Increased collaboration with suppliers is a manner to improve supply chain visibility and traceability leading to increased transparency (Sodhi and Tang, 2019). Consequently, information sharing in a multi-tier perspective and increased communication is essential for increased supply chain performance (Grimm et al., 2016; D'Eusanio et al., 2019) and firm performance (Ahmed and Omar, 2017; Wiengarten, Humphreys, Cao, Fynes and McKittrick, 2010).

The most essential factors influencing transparency in supply chains are formalized information flows, monitoring, and trust between parties in the supply chain (Ahmed and Omar, 2017). Supplier collaboration is needed to create multi-tier initiatives in the global supply chain, thus communication and knowledge sharing are aligning and supporting suppliers within the global supply chain (Sodhi and Tang, 2019). In addition, supply chain decision-makers should build long-term relationships with suppliers (Li, Li and Xie., 2019). Supply chain relationships are defined as the flow of information in the process of negotiation and collaboration and have a function of limiting the spread of false information (ibid). By establishing relationships, this provides larger commitment, flexibility, and increased information flow in the supply chain (Almeida et al., 2017). Accordingly, supply chain relationships are needed to increase collaboration and to further enhance traceability within supply chains (Tan et al., 2018). Furthermore, Koberg and Longoni (2019) stress the need for multi-stakeholder initiatives and investments to improve collaboration and governance, meaning that collaboration with other companies, civil society, or governments is essential and lead to improved supply chain sustainability. Moreover, the interaction between organizations is crucial to reduce transaction costs and gain the required resources for production (Li et al., 2019).

Implementation of multi-tier systems

Abdullah and Musa (2014) argue that enhanced supply chain relationships increase the level of commitment, which determines the feasibility to integrate business processes in a supply chain. On the other hand, the supply chain relationship must be enhanced by network centrality and information sharing (Qiao, Niu, Kifer, Fernández-Martínez and Guirao., 2018), indicating the dual interconnectedness and mutual dependency between the functions. To increase communication and efficiency in supply chains, information - and communication sharing platform could be implemented (Li et al., 2019; Qiao et al., 2018). Companies' investments in new technology with the purpose to enhance trust and supply chain relationships in a long-term perspective enhance the responsiveness in supply chains (Liu, 2018; Li et al., 2019).

Digitization of supply chains has been a great concern within the automotive industry for years as the industry is lacking modern systems regarding monitoring, traceability of information and product flow, as well as end-to-end disclosure of information (Korpela et al., 2017). The need for supply chain coordination is resource consuming (Chaudhuri et al., 2018), which implies that there are concerns regarding time and costs involved in companies' implementation of a common management system. It is difficult to integrate systems as many electronic devices are not compatible on an inter-organizational level (Korpela et al., 2017). This is supported by Koberg and Longoni (2019) who stress that geographically dispersed supply chains complicate information sharing. Shi et al., (2019) agrees, although, stating there is a need to integrate information resource flows. Currently, product traceability is conducted only in certain stages of the supply chain and it is difficult to implement traceability due to different technologies and standards in the supply chain as data management often is conducted in silos (Bateman, 2015). In addition, Vanichchinchai (2019) underlines that many supply chain relationships fail due to different organizational and cultural views, making it incompatible to implement common management systems. At the same time, despite that information flow is an important source providing essential benefits to the MNCs, the lower-tier suppliers may be unwilling to share information (Sodhi and Tang, 2019). Further, it might be issues regarding privacy protection and confidential information, thus prohibiting information transparency, which is arguably a mutual concern for all parties (Shi et al., 2019). Therefore, this may partly explain why there are fragmented views on data management in the supply chain (Bateman, 2015).

2.4 Blockchain Technology

Satoshi Nakamoto was pioneering the world of technology when releasing the technology of blockchain in 2008 in the shape of the first digital cryptocurrency Bitcoin, which is an electronic peer-to-peer cash system (Nakamoto, 2008; Lemieux, 2013; Lin, Shen, Maio and Liu, 2018). Since then, the blockchain technology has expanded significantly, but continuously surrounding around its main feature, to establish trust (Angelis and Da Silva, 2019). It has developed from the financial service industry where the purpose is to ensure inter-actor digital trust and is now transformed into a technology that is applicable to a vast amount of areas where trust is a central concern, such as shipping, e-government services, and product provenance (Biswas and Gupta, 2019). Accordingly, the characteristics of the blockchain technology and its value creation have increased the interest to use it for multiple purposes within a wide array of industries (Pan, Pan, Song, Ai and Ming., 2019).

2.4.1 Description of Blockchain Technology

Blockchains can be seen as an infrastructure or a platform on which different features may be built upon, (Biswas and Gupta, 2019). It has also been described as a distributed ledger that records transactions between two or more parties (Seiffer-Murphy, 2018). Within the system, each block is containing a cryptographic hash and are interconnected on a global scale, forming a block of chains (Venkatesh et al., 2020), which is established by multi-collaboration (Tapscott and Tapscott, 2016). The electronic transaction through the different blocks combined provides a complete ledger of the transaction history in a protocol (Nofer, Gomber, Hinz and Schiereck, 2017). This ledger serves as decentralized data information, meaning that

there is no central storage as it is directly connecting users with the information in the block (Angelis and Da Silva, 2019). Thus, the infrastructure is not owned or controlled by one single entity but is built upon a joint network ensuring the proper functioning of the blockchain (Hughes et al., 2019). All actors on the blockchain are owning a copy of the ledger, called nodes (Bauman, D., Lindblom, P., & Olsson, C., 2016; Laplume, 2018). Put short, each block that is entered into the chain and into each node consisting of a header and a body. The former is containing the set of rules that should be followed for validation of the block, and the latter contains the list of prior transactions (Azzi, Chamoun and Sokhn, 2019).

Blockchain is a tamper-proof system with a secure, immutable function in the shape of a consensus mechanism, meaning that all nodes confirm the validity of the transaction at hand, by interdependently verifying the authenticity based on prior transactions in previous nodes (Hughes et al., 2019). To clarify, when a new block is entered into the blockchain and reaches consensus, meaning that all existent blocks accept the data and verifies that the transaction is valid, a copy of the block is sent to everyone in the network (Laplume, 2018; Biswas and Gupta, 2019; Hughes et al., 2019). This is a key principle in the blockchain technology, which replaces the previously needed intermediary to establish trust in transactions, by enabling trustless transactions and full audit trails (Feng et al., 2018; Angelis and Da Silva, 2019; Hughes et al., 2019). By immutability it is meant that data that has been entered onto the blockchain can not be altered, as all ledgers in the network have the data chronologically stored (Hughes et al., 2019). Therefore, it is not possible to delete, change or update the information (Yadav and Singh, 2019), and to this date it is impossible to hack (Hughes et al., 2019). Meaning that if a correction has to be made, similar to the procedure in accounting, this must be made by creating a correction to that information, which will be visible (ibid). The study by Venkatesh et al. (2020) documents how the security of the transfers and integrity of data transactions are maintained through the use of public and private keys held by stakeholders serving as a digital signature. The data inserted into the block is called a hash, and this is a unique value that is helping to identify the block and the series of transactions (Biswas and Gupta, 2019). This function enables transparency to the actors and thereby contributing to a traceability system that can benefit supply chains (Venkatesh et al., 2020).

Despite the fact that the blockchain technology is still immature and constantly developing, it might not be suitable for organizations at hand. It has to be adapted to each organization and industry in order to create value (Roeck et al., 2019). Consequently, several authors emphasize that blockchain needs more time for widespread implementation (Hughes et al., 2019; Roeck et al. 2019). Similarly, Norberg's (2019) study show that the technology and business are argued to need up to five years until there is a more general understanding of the advantages of blockchain's transparent transactions, as it adds a new layer of trust and accountability in international trade (Norberg, 2019).

2.4.2 The Configuration of Blockchain Technology

The blockchain technology can be categorized based on different levels of restrictions (Azzi, et al., 2019; Biswas and Gupta, 2019), commonly referred to as permissionless and permissioned blockchain (Azzi, et al., 2019). These are further divided into the subcategories

private, consortium, and public blockchains (Biswas and Gupta, 2019). Permissionless blockchain technology is described as the public blockchain as it is an open network, accessible to every user (node), has no ownership, and is highly decentralized (Bauman et al., 2016). One real use case of this is Bitcoin, which is an open network where all users have the same conditions (Nakamoto, 2008; Bai and Sarkis, 2020), and are able to participate without revealing the identity (Yadav and Singh, 2020). However, public blockchains are faced with the concern of incremental amounts of data which requires scalability and rigorous amount of energy (Rejeb et al., 2019).

Permissioned blockchain technology may be either private or consortium (Biswas and Gupta, 2019). In contrast to a public blockchain, a permissioned network is a controlled distributed ledger, meaning that one actor is being able to add restrictions on the network, such as what actors that can join and what information can be seen and entered (Biswas and Gupta, 2019). A private blockchain is controlled by one single entity, requires an invitation to join the network, and is characterized by a set of rules constructed by the network starter (ibid). Consequently, the private blockchain can be set up in a way that some actors have the authority to contribute with information to the chain while some actors are only able to view the information (Norberg, 2019). On a private blockchain, an actor is not anonymous as the identity of a participant is known to the other nodes (Azzi et al., 2019). On the other hand, this configuration is faced with discussions regarding privacy creating a monopolistic approach of the network (Rejeb et al., 2019). The consortium blockchain is mainly referred to as a hybrid of the public and the private blockchain configuration, often referred to as 'semi-private', as it has a controlled user group but operates across different businesses (Zheng et al., 2016; Biswas and Gupta, 2019). However, despite different kinds of blockchain technologies, all contain the core characteristics of transparency, reliability, and invariability of data (Baralla et al., 2018).

2.4.3 Blockchain Enablers in Global Supply Chains

The blockchain technology has several key features that are argued to be the key constructs to improve global supply chains (Kshetri, 2018; Queiroz and Wamba, 2019). This is supported by Bai and Sarkis (2020) underlining that blockchain technology is enabling supply chain traceability and transparency, which Baralla et al. (2018) and Roeck et al. (2019) emphasize would fulfill end-users and stakeholders' demand for transparency. The blockchain technology is optimized when having a high number of connected nodes, which makes it suitable for complex supply chains with numerous actors (Bateman, 2015). At the same time, it has to be mentioned that the adoption of blockchain in the supply chain is in its infancy (Queiroz and Wamba, 2019).

In a supply chain context, a blockchain network contributes with safe, traceable, and transparent transactions, which has a positive impact on the efficiency in the supply chain. Recent studies that have investigated the impact of blockchain on supply chains, highlight the enhanced transparent and efficient transactions (Kshetri, 2018). Further, improved data exchange that enables information sharing beyond the first-tier supplier (Schmidt and Wagnes, 2019). Moreover, increased product traceability (Chen, 2018), trust, and reliability in the supply chain network (Queiroz and Wamba, 2019). The ledger is transparently registering

details of the production and track a product throughout the entire supply chain, from raw material to end-consumer, thus reducing the need for a third-party validator, intermediaries, subsequently, increase trust and transparency for stakeholders (Hughes et al., 2019, Saberi et al., 2019). Previously, traceability has been conducted through eg. RFID systems, which are a digital cloud-based traceability system with digital identity cards placed on each product (Bateman, 2015; IMD, 2019). However, deploying a blockchain-based traceability system, enable the feature of designing a suitable tracking device dependent on the specific component at hand, which is improving the accuracy of traceability and enhance transparency (Azzi et al., 2019). Bai and Sarkis's (2020) study also show that the level of transparency that blockchain brings to global supply chains is the most prominent contribution, in comparison to other technologies and systems available. Therefore, blockchain has emerged as a solution for current global supply chain concerns (Roeck et al., 2019).

Other effects that have been discussed is that the use of blockchain may lead to a segregation effect, where actors that have nothing to hide will be part of the blockchain network and disclose information. Subsequently, this enables companies to make more informed decisions and evaluations of suppliers (Roeck et al., 2019). In addition, decentralized information increases business integration within the supply chain (Korpela et al., 2017). The study by Schmidt and Wagner (2019) derive insight into that blockchain is reducing governance costs in the supply chain, as it reduces search and information costs due to the secure, automated post-contract control in the ledger. This further supports improved monitoring and compliance (Roeck et al., 2019). Subsequently, blockchain is safeguarding the prevailing risk of opportunistic behavior in the supply chain (Schmidt and Wagner, 2019).

2.4.4 Implementation of Blockchain Technology

Despite the multiple reported advantages with blockchain technology, argued to revolutionize global trade (Norberg, 2019), blockchain also brings complications and questions in regard to adoption (Queiroz and Wamba, 2019; Wong et al., 2020). Firstly, there is limited knowledge available regarding the technology in terms of what is required in order to implement blockchain, as there is poor information available in this field (Hughes et al., 2019; Venkatesh et al., 2020). In addition, the effects of blockchain technology are difficult to predict prior to implementation (Bai and Sarkis, 2020), and managers might not have the required knowledge to assess the potential of blockchain for their specific company in their specific industry (Roeck et al., 2019). Similarly, in the study by Wong et al., (2020), it was found that there is a low level of blockchain awareness, and low managerial interest of the new technology which had a significant impact on the adoption. In fact, transparency and traceability might still be areas not invested in for companies, and this may create larger resistance to implementation (Bai and Sarkis, 2020). There is a lack of industry-standards on how to ensure traceability, thus what technology that should be implemented to increase transparency (Rejeb et al., 2019). This issue is complicated further as there are multiple decision-makers with deviating interests and opinions that have to be aligned in the implementation process, meaning that several stakeholders need to agree (Bai and Sarkis, 2020).

Moreover, blockchain technology enables transparency, increases scrutiny from customers and other stakeholders, which requires companies to be prepared in order to not be exposed to other actors (Montecchi, Plangger and Etter, 2019). It may be a challenge to ensure that the blockchain technology used in a firm is open to all relevant parties and simultaneously guaranteeing that only valid transactions are added (Hughes et al., 2019), as blockchain is, in fact, a database and does not govern data acquisition (Schmidt and Wagner, 2019). Therefore, it has to be ensured that the blockchain is secured, thus that transferred data is encrypted and properly signed (Azzi et al., 2019). Similarly, Wong et al., (2020) underline that the risks for revealing trade secrets, intellectual property, and supply chain details, have to be ensured in advance. It is also important for firms to do a careful analysis of all stakeholders and their reactions to a fully transparent supply chain (Montecchi et al., 2019), as uncertain investments are subject to regrets and conflicts (Bai and Sarkis, 2020). However, there is a novelty in blockchain application in supply chains, therefore the level of uncertainty is arguably going to decrease as the technology matures (Schmidt and Wagner, 2019). As for now, it is evident that there are both intra-organizational, inter-organizational systems related barriers and external barriers for companies to adopt blockchain in order to increase traceability to enhance sustainability in the global supply chain (Saberi et al., 2019).

2.4.5 Blockchain Use Cases

In practice, the most prominent use cases for the supply chain are seemingly provenance cases, thus successful use cases of blockchain with a traceability purpose, in order to establish the source of origin of products (Bai and Sarkis, 2020). As previously described, Walmart has implemented blockchain to establish a food traceability system that ensures farm-to-plate traceability (Kamath, 2018; Tan et al., 2018). Another supply chain use case of blockchain and traceability is exemplified in the blockchain technology platform called Everledger, which enhanced greater transparency in the diamond supply chain to eliminate forced labor use across Africa (Bai and Sarkis, 2020; Everledger, 2020). In fact, the diamond industry has large customer pressure to assert provenance, and companies are working to prevent fraud and counterfeit diamonds (Weygand et al., 2019). To clarify, blockchain's ability to hash code all events, allowing for a sequential track record enables all actors in the chain to verify the accuracy of the data in the blockchain and ensure place and time for the product registration on the blockchain (Baralla et al., 2018). Meaning that the technology can trace the steps from the time the diamond is collected until they are sold to a customer in the store. This is important for the diamond industry as they are operating in an industry known for conflict zone sourcing and blockchain ensures compliance to ethical and responsible sourcing (Everledger, 2020; Weygand et al., 2019). The use of blockchain technology enables information such as documents, product identity and identity of actors involved in the transactions, in order to establish the quality and authenticity of the products, subsequently benefiting sustainable global supply chains (Baralla et al., 2018).

2.5 The Conceptual Framework

The conceptual framework was developed in order to examine the research question and is based on the reviewed theory and includes the key concepts, centered in two constructs. The two constructs are representing, one state without blockchain, labeled 'current state', and one state where MNCs have implemented blockchain, labeled 'blockchain state'. Each construct contains five equivalent themes and represents a synthesis of established theories relevant to explaining the MNC's global supply chain implementation barriers to using the blockchain technology.

Firstly, MNCs are embedded in global supply chain networks, (Aydin et al., 2014; Chaudhuri et al., 2018), and are traditionally focusing on the first-tier supplier (Koberg and Longoni, 2019). Therefore, the rectangle constitutes the basis for this study, visualizing the different tiers in the supply chain network. MNCs are engaged in governance activities in order to increase knowledge of the global supply chain (Shi et al., 2019). This is a result of that MNCs are increasingly held accountable for the supply chain in a more holistic view, leading to increasing governance of the global supply chain (Boström et al., 2015). The governance of the first-tier supplier is also characterized by both contractual governances, as well as, relationships and information sharing in a more non-contractual manner (ibid). These two governance strategies are represented in the two arrows between the MNC and the first-tier supplier, resulting in a traceability and governance range (Sodhi and Tang, 2019). Following the agency theory (Eisenhardt, 1989a), there is a governance gap beyond the first-tier supplier, meaning that unknown compliance to desired standards in sub-suppliers is a challenge (Villena and Gioia, 2018), visualizing that there is lacking in global supply chain transparency.

Secondly, the blockchain state is synthesized of theories relevant to compile an imagined state where the MNC and the global supply chain are running blockchain technology. In the blockchain state, inter-organizational integration is necessary to increase transparency range (Carters and Rogers, 2008), and it is suggested that the new technology should enable this (Astill et al., 2019). In the framework, blockchain is providing transparency (Biswas and Gupta, 2019; Hughes et al., 2019). As visualized in the second construct, in the blockchain state, this results in an increased governance range including all tiers in the MNC's global supply chain, and an increased range of traceability and transparency (Baralla et al., 2018). In turn, blockchain is altering the current governance system, as visible when comparing the two constructs.

The conceptual framework is developed based on the assumption that it is possible for an automotive MNC to implement blockchain in their global supply chains in order to increase the governance range. Although, being dependent on factors within the five themes, consisting of the MNCs inherent driving forces, thus the motivation and challenges, global supply chain characteristics, thus contractual, and - non-contractual governance, and blockchain facilitators which represent additional influential factors, based on empirical findings, consisting of bargaining power and industry collaboration. Further, to implement blockchain is complicated and the process is labeled with several concerns (Saberi et al., 2019; Venkatesh et al., 2020).

The arrow with a question mark between the constructs, the current state, and the blockchain state, illustrate the imagined transition to a blockchain state, containing barriers for MNCs to implement blockchain in their global supply chains.

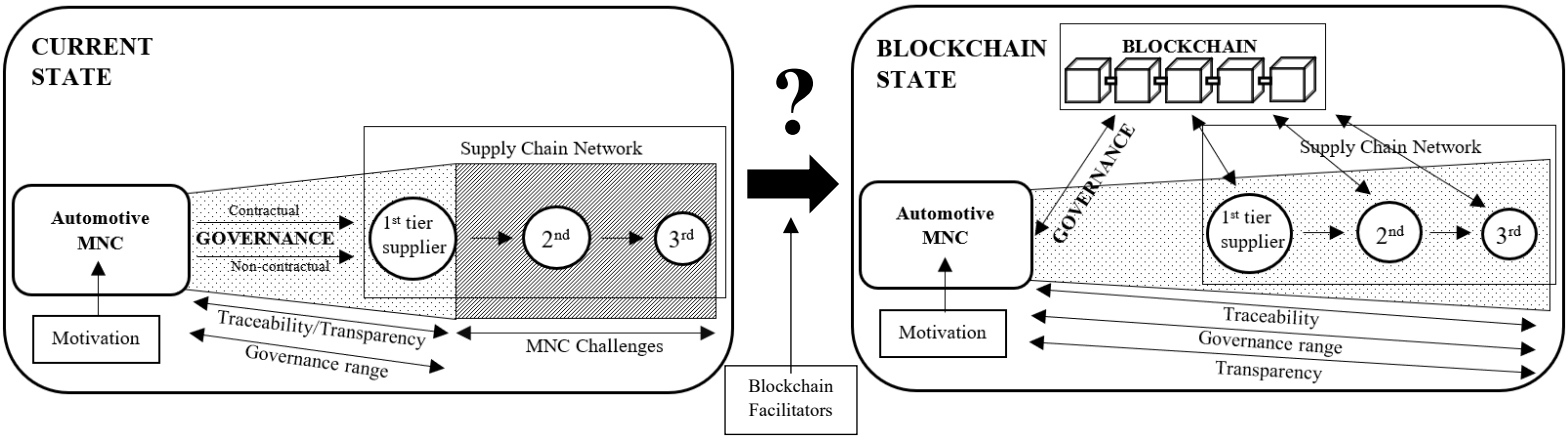

Figure 2.2 The conceptual framework. Compiled by authors.

3 Research Methodology

The ambition of this chapter is to present the methodological choices, decisions, and actions taken throughout the research in order to enhance the transparency of the study. The themes presented are the research strategy, method and design, the data collection and analysis, and the quality of the research method.

3.1 Abductive Research Approach

This study is inspired by Dubois and Gadde's (2014) definition of a systematic combining, also known as an abductive approach. The continuous matching between theory and empirical findings is seen to be particularly useful in this thesis as blockchain is a new technology and the use of it within MNCs global supply chains is still fairly limited. Therefore, it is beneficial that theory and hypothesis are not set prior to the study, as it requires investigation through interviews to add upon existing theoretical framework (Eisenhardt, 1989b; Yin, 2018). The conceptual framework and the research question have been adjusted in parallel with the empirical data collection and case analysis. Further, the analysis chapter has been creating theoretically and empirically developed propositions to enable answering the research question. Propositions are well suitable as the qualitative data gives in-depth answers to the causality of the subject (Yin, 2018). Accordingly, the conceptual framework has continuously been guiding the exploration and analytical iteration process of cause and effects, in order to contribute to the theoretical field of blockchain and supply chain governance.

From the initial stage a deductive reasoning was influencing the conceptual framework (Yin, 2018) as it was created from existing theory field of the technical aspects of the blockchain technology and global supply chain governance. Later on, the data collection provided an additional understanding of the social and contextual constraints in automotive MNCs' global supply chains and the application possibilities of the blockchain technology, leading to knowledge regarding the implementation barriers. In detail, the research has been adapted as a result of the findings that the MNCs had limited experience of blockchain, and that blockchain, in contrast to the researchers' prior view, is not related to sustainability, rather transparency. Thus, this has shaped the research question and the theoretical framework to decrease the focus on sustainability and highlight transparency. Further, increased focus on blockchain as a tool, which increases the governance range significantly, is also an adaptation that was made. Therefore, MNCs' motivation for transparency and blockchain, challenges within the global supply chains, governance modes, and blockchain implementation implications were added as theory sections and to the conceptual framework. However, bargaining power and industry collaboration are two theory generating views derived from the data and found to be important for both supply chain governance and blockchain implementation, which is also added to the conceptual framework and are labelled blockchain facilitators.

3.2 Qualitative Research Method

This study follows a research strategy including a qualitative and exploratory approach, which is preferred due to the under-research area of blockchain and transparency in automotive

industries global supply chains and to be able to gain findings to develop relevant propositions. In addition, blockchain is a fairly new technology lacking real-life practical cases, thus characterized by high uncertainty resulting from lacking knowledge. Therefore, based on Bryman and Bell (2019) and Yin (2018), the orientation of a qualitative strategy has been chosen to enable different dimensions and views from several automotive MNCs' to gather knowledge and understanding from an organizational perspective. This has enabled a subjective impression of reality within this particularly unexplored subject (Bryman and Bell, 2019) and has been advantageous in the process of answering the research question. Especially, the respondents in the study need to express beliefs, opinions, and constraints, in order to gather an understanding of the potential barriers to increasing transparency by applying blockchain technology. Therefore, a qualitative study is useful as it allows for adapted follow-up questions (Yin, 2018), in contrast to a quantitative strategy. Subsequently, this opens up for opportunities to gather more data from the interviewees' point of view, which fulfills the purpose to develop the conceptual framework, propositions and enables answering the research question to a deeper and greater extent.

3.3 Multiple Case Study

The multiple-case study design is considered to be a suitable research design for this study as this allows exploration of a new phenomenon. Different cases provide rich data and allow for cross-validation (Dubois and Gadde, 2014; Eisenhardt 1989b; Yin, 2018), which helps to create an understanding and bring clarity about not only the empirical findings from in-depth interviewees but also having a holistic approach and add upon the existing theory giving the variation needed to develop propositions. The expanded theory collection can bring together several patterns (Yin, 2018), regarding the implementation barriers of blockchain, from both an MNC perspective and blockchain experts' point of view. Further, to use a multiple case study as a research design is arguably better grounded, more accurate, and more generalizable compared to a single-case study, as multiple cases might yield different views (Dubois and Gadde, 2014). This is pivotal as different reflections upon current challenges and what organizational activities are related to governance and implementation of blockchain in MNCs global supply chains is needed. Accordingly, the use of several real-world sources of evidence to collect information to answer the research question is strengthening the quality of the study by enabling the researchers to identify similarities or differences between cases (Yin, 2018). This is done by conducting interviews with both MNCs and blockchain experts, as well as secondary data sources, to verify the potential implementation barriers of blockchain by addressing governance and transparency in MNCs' global supply chains. Consequently, making the study more robust and it generates confidence due to more information regarding the topic and can further create new theory (Dubois and Gadde, 2014; Eisenhardt 1989b; Yin, 2018). In contrast, Dubois and Gadde (2014) argue that it can be difficult to get a deeper knowledge of each case using a multiple case study, which complicates comparison. However, based on Yin (2018), in this study it is believed that the design is powerful when it comes to the analytical aspects, as it provides several angles from different automotive MNCs and enrich the empirical data.

3.4 Data Collection

An appropriate research methodology is essential to ensure a collection of relevant and correct data as well as to increase the systematic structure and trustworthiness of the data collection process (Yin, 2018). For this study, the employed key method was a primary data collection mode, consisting of interviewees through an accurate interview process, and a secondary data collection. Therefore, this section is divided into subsections, secondary- and primary data collection, and the interview process.

3.4.1 Secondary Data Collection

The secondary data collection has been used by the authors first to gain an understanding of the subject and relevant theories from prior research, in order to start to develop a conceptual framework. The collection started before this study was presented in order to find a research gap and an interesting field to examine in greater detail, to justify the research question and the construction of the research design (Bryman and Bell, 2019). Accordingly, this process helped the authors to gain knowledge of the topic prior to the primary data collection and served to the method of constant matching, thus the development of pre-propositions and interview questions. However, the secondary data collection also complemented and verified the credibility and validity of the data collected from the primary data, as it is a complex topic and further clarifications have been needed in order to gain knowledge of the implications of blockchain and transparency in global supply chains. Consequently, the authors have been working actively to ensure that the thesis is built on the most relevant knowledge within the field of global supply chain governance and blockchain technology.

In order to capture valuable information within this new research field, the secondary sources that are included in the study are peer-reviewed scientific articles and newspapers. These were written in English or Swedish and have a coherent alignment with the set research question, thus enable correct information within the scope of this research field. With a few exceptions, the main focus has been on collecting articles on blockchain in global supply chains, published from the year 2018, with emphasis on articles published in 2019 and 2020. This is due to the large amount of recent and more relevant research that has been published in the last years as there is a high speed of development of blockchain technology. There is a wider spread of the publication year regarding research on MNCs, global supply chains and governance, albeit more recent articles have been emphasized when having news value.

3.4.2 Primary Data Collection

In order to gain rich and extensive answers, aligned with this exploratory multiple case study, a guided conversation methodology has been used, meaning that an interview guide supported the interviews (Yin, 2018). This is due to the importance to achieve flexibility and open-ended exploratory questions, based on prior theory but open for learning opportunities. Accordingly, two semi-structured interview guides were designed (Appendix B) out of multiple distinctive themes (Bryman and Bell, 2019; Yin, 2018). One guide suitable for the blockchain experts and one guide for the MNCs, further discussed in *3.4.3.1 The Interview Guides.* Throughout the primary data collection process, the conceptual framework has been adjusted along with the

propositions, which in turn modified the pre-designed questions in the interview guide in order to collect relevant and purposeful data.

3.4.2.1 Motivation for the Primary Data Collection

There has been a twofold purpose for having two groups of interviews, automotive MNCs' and blockchain experts. These different perspectives provided different specific knowledge and information in order to answer the research question thoroughly. The authors wanted to understand the potential gap for the MNCs to address transparency by using blockchain in global supply chain governance. Therefore, to be able to pose related questions to blockchain experts, in addition to MNCs', provided a wider understanding of the compatibility to adopt blockchain technology and created greater knowledge of the implementation barriers.

The blockchain expert interviews are used to both add to the current literature and verify the information in the secondary sources. This is called triangulation, which is further explained in *3.6.1 Validity.* Triangulation is of particular importance in this case as the subject is complex, lacks practical use cases in organizations and the current literature is new and rapidly developing. Moreover, two of the four blockchain interviews were conducted prior to the interviews with the MNCs, as this could develop the authors' understanding of the most relevant areas of blockchain usage in global supply chains. The remaining two blockchain interviews were conducted during the MNCs interviews to extend the understanding of the MNCs' responses.

Regarding the MNCs, initially 30 MNCs' within the manufacturing industry were contacted. However, nine out of twelve companies that were interested in participating were in the automotive industry. Consequently, to make the thesis more focused, the scope was limited to the automotive sector. This choice is aligned with Eisenhardt (1989b), meaning that the cases should have the possibility to be replicable, which is enhanced by conducting a focused study rather than having a broader cross-industry sample which could have inter-industry variances. In addition, this narrow sample was found suitable as the automotive industry is experiencing increasing challenges in terms of stakeholder pressure to increase transparency and have complex global supply chains (Yong-Shin, Kim and Yong-Han, 2018: HBR, 2017). Therefore, these nine companies within the automotive industry were selected to gain a sufficient amount of data to answer the research question, thus ensure *3.6.1 Validity* (Yin, 2018).

3.4.2.2 Selection of Blockchain Experts

The cases included in the study have been selected based on the expectation to maximize the learnings (Bryman and Bell, 2019; Yin, 2018). To clarify, by blockchain experts it is referred to a person who has a high level of skills, being acknowledged for the knowledge held in the specific field. The blockchain experts were selected by two criteria. Firstly, the interviewees are at the forefront and actively working with blockchain, either in their business profession or within academia having blockchain in their main research field. Secondly, they are located in Sweden as the researchers preferred face-to-face interviews due to the complexity of the subject. However, two of these four interviews were rescheduled to Skype interviews, due to

the circumstances of the Covid-19 outbreak. Moreover, in the study, there are two interviewees being a researcher from the academy and two from the business world being a blockchain engineer at a blockchain-based start-up company and consultancy firm. These different backgrounds enhanced a nuanced view on the ability to use blockchain with the purpose of increasing transparency in supply chains, both out of a technical perspective and a business perspective. The blockchain experts is further presented in *3.4.3.2 Conducting the Interviews* in *table 3.2.*

3.4.2.3 Selection of MNCs and Interviewees

The selection of the automotive MNCs' for the study was specifically conducted based on the following criteria. Firstly, to be defined as an MNC, the company needs to have a centralized headquarter function in one country while operating, thus having value-adding activities in plural countries, and being embedded in multiple networks (Mayrhofer and Prange, 2015). Secondly, to suit the purpose of this study, the MNC must be involved in complex global supply chains involved in sourcing of raw material in developing countries. Thirdly, the MNCs selected to be included in the study are in the automotive industry and have revealed in their annual or sustainability reports that they have a social sustainability engagement, and governance systems related to these. The criteria were valuable to include companies that have an established interest to increase responsibility and traceability in global supply chains to improve transparency, thus being able to provide valuable information for the study. However, the sample size, to include the nine automotive MNCs as described in *section 3.4.2.1*, was also restricted to the researchers' ability to contact relevant companies for the study considering the time frame and scope of the study.

In order to provide appropriate knowledge, and increase the likelihood of a mutually valuable interview session, an email was sent out regarding the thesis topic, the purpose of the study, and what areas of expertise the participant likely would have (Appendix A). The purpose was to ensure that the interviewee had extensive knowledge and practical, daily insight into how the MNC is working with sustainable supply chain governance and transparency, such as procurement or supply chain manager, sustainability manager, and technology development manager. These aspects are seen as vital to enhance the quality of the study (Bryman and Bell, 2019). The email was sent either directly or via the researchers' network having a prior contact person at the company, or by referrals by previous interviewees. Subsequently, this ensured accessibility, compatibility, and ensuring that the participants were cooperative.

To increase the quality of the answers from the collected data and to include different points of view, the aim was to include two respondents from each MNC. However, due to access constraints and particularly difficult circumstances resulting from the Covid-19 outbreak making the automotive sector close down, the ambition to include two participants in each company succeeded for two companies. In addition, when the interview process was due, three companies had to cancel the interviews as a result of layoff restrictions making them unable to answer work-related questions. Consequently, the final sample is including eight interviews with six companies, presented further in *3.4.3.2 Conducting the Interviews* in *table 3.3*, and the case companies included in the study are presented below in *table 3.1.*

Case companies included in the study						
Companies	Volvo Cars	Company X	Scania	Volvo Group	Volvo Buses	Volvo Trucks
Headquarter	Sweden	Germany	Sweden	Sweden	Sweden	Sweden
Vechicle focus	Cars	Cars & Trucks	Trucks	Trucks	Buses	Trucks
Degree of blockchain implementation	Implemented	Pilot	Pilot	Pilot	-	-

Table 3.1: Case companies included in the study. Compiled by authors.

3.4.3 The Interview Process

Throughout the interview process, the researchers moved back and forth between the empirical findings and theory, as the interview process redirected the content and continuously changed the conceptual framework (Dubois and Gadde, 2014). The process is described more in detail in the following sections.

3.4.3.1 The Interview Guides

To conduct open-ended and conversational interviews, two interview guides were prepared in advance in order to ensure that the relevant topics were discussed during the interviews (Appendix B). The two guides were developed simultaneously where the interview guide for blockchain experts is of a more explorative character while the MNCs guide is based on the theoretical framework to a larger extent, however with room for elaboration due to open-ended questions. Aligned with the abductive and systematic combining approach (Dubois and Gadde, 2014), the conceptual framework was continuously developed when more empirical data was gathered. Therefore, the interview guides have been modified to match the conceptual framework. More in detail, the interview guides were adapted based on new knowledge after the two initial blockchain experts and the two initial MNC interviews, as these revealed more essential areas to cover, which is in conjunction with the thesis explorative approach (Yin, 2018). Specifically, the interview guide to the MNCs' had to be adjusted as the level of blockchain implementation was found to be fairly low, resulting in low prior knowledge of blockchain technology. Thereby, changes to relevant areas such as the interviewees' perception of participating in an industry-wide open platform and the use of different blockchain configuration characteristics have to be covered on a broader level than initially expected. Additionally, in some cases, the interview guide was adapted to the case at hand in order to ensure appropriate information, based on the respondent's knowledge and expertise. However, due to the changes and unforeseen pressured time limits of the data collection process, as a result of the Covid-19 outbreak, there were fewer changes in the interview guide than initially expected.

Based on Yin (2018), the interview guides were structured into themes to gather the most valuable data. Specific questions regarding the subjects within each theme were aligned with the purpose of the interview, designed aligned with the necessity to create a versatile conversation with the possibility for the respondent to elaborate on the question, allowing for unpredicted information to emerge and worded to not distort the questions. Prior to the interviews, both guides were sent to an external person having an objective view on the content, and through feedback, the interview guides were refined and developed further. The two

interview guides differ a bit as one is for the MNCs' and one for the blockchain experts', were the blockchain experts' guide primarily is focusing on adding knowledge to the existing blockchain theory. The guide for the blockchain experts contains the technical aspect of using blockchain in global supply chains, blockchains enablers, blockchain limitations, and implementation characteristics. On the other hand, the interview guide for the MNCs in the automotive industry is built upon the five themes regarding motivations, challenges, contractual - and non-contractual governance, and blockchain facilitators. It was established at the introduction of the interview for the respondents' that all questions are connected to the upstream global supply chain specifically.

The two guides were formulated with the language and topic adapted to the respective interview group, as it was difficult to predict the level of knowledge regarding the specific theme of blockchain. Accordingly, at times the topic of the blockchain technology and the path towards traceability had to be discussed in a simple manner, ensuring that different interviewees received the same questions and perceived the questions similarly. This was done in order to increase the probability of achieving a comparable sample of the participants' comments (Yin, 2018). As the interview sessions were of an explorative character it enabled the participants to express their own opinion and thoughts, thus reducing the influence of the researchers. This implies that the interviews are characterized by the respondents and their answers, aligned with the semi-structured research approach. However, the interview guides were designed more strictly than usually advised (ibid), in order to ensure that all themes were discussed within the limited time frame of the interview sessions.

In the preparation for the interviews, an email was sent out to the participants a couple of days in advance, to remind them of the date and time, as well as preparing them for the main themes that were to be discussed during the interview session. This was made to ensure that the respondent could prepare properly, however without preparing exact answers. Subsequently, the researchers could capture the actual experiences and more spontaneous reactions regarding the questions. Moreover, a new copy of the interview guide was brought to each of the interview sessions. Subsequently, when a theme was discussed it was crossed out, ensuring that all information needed is gathered and not asked repeatedly.

3.4.3.2 Conducting the Interviews

The interviews were planned and scheduled to be conducted face-to-face and presented below in *table 3.2 and 3.3.* However, the emergence of the Covid-19 epidemic's outbreak occurred quickly and unexpectedly in the month of March 2020, the same period as all the interviews were scheduled. Consequently, although the researcher's ambition and intention were to conduct solely face to face interviews, the respondents got restrictions from their employers forcing the interviews to be rescheduled to video calls. The study had to adapt to the new circumstances even though it is known to be more beneficial with face-to-face interviews. Especially as the interviewee tends to be more engaged and makes the researchers achieve a higher level of understanding in terms of interpretations of statements, verbal and body language as well as environmental influences (Bryman and Bell, 2019). However, methods such as Skype and Facetime are argued to be a good alternative to face-to-face interviews as

the solutions offer visual and audio connectivity. The largest challenges for replacing face-to-face interviews lay within potential technical difficulties and problems that may occur, as well as potential lack of user familiarity with the software (Mirick and Wladkowski, 2019). However, to decrease the problematics of the above, the interviews were jointly conducted by both researchers and used both cameras and a high level of a phonogram to increase the understanding of expressions through body and eye contact.

The interviews lasted approximately 60 minutes each, were recorded after the respondents' approval and notes were taken during the interview. This ensured that more interesting topics were highlighted and enabled relevant follow-up questions. Further, subtle notices such as how the respondent answered, body language, and small details that the recorder does not catch were documented (Yin, 2018). Subsequently, this complemented the transcription process and analyses of the data. After each day when interviews had been conducted, these were transcribed in order to have the interview close in mind. Simultaneously to keep track of what had been discussed in each interview session, matching the data with the conceptual framework. In addition, each interview was recorded and reviewed by both researchers, to decrease the risk of misunderstandings, but transcribed by one researcher along with the notes taken during the interview.

Moreover, the interviews were conducted in Swedish or English, as most interviewees are Swedish and it was, therefore, natural to conduct the interviews in the mutual language. Subsequently, this facilitated the comforts and the ability to express thoughts in a more natural manner and the ability to be more precise in wording and meanings and reduce the risk for translation misinterpretations. Although, Swedish answers needed to be translated into English, which impacted the transcription process. To minimize the risks of language misinterpretations, both researchers carefully went through the recordings and transcriptions, to ensure that the translation was as close as possible to the original language. Although, the number of interviews was decreased due to the Covid-19 outbreak, as described above. The variance in answers decreased by the end of the interview process and the value-added per interview declined, thus indicating that the research reached some degrees of saturation. Additionally, during the data analysis process, it was considered that there might be a potential bias as the interviewees are representing a company and the topic at hand might contain information that is sensitive to reveal. Meaning that the interviewees may withhold information regarding their transparency and sustainability work, as they may be afraid that information can be interpreted negatively about their workplace. However, this has not been perceived as problematic as the interviewees to a great extent have been frank and open about their challenges and inabilities within the field.

BLOCKCHAIN EXPERTS				
Expert	*Title/Experience*	*Date and Duration*	*Type of Interview*	*Language*
Juho Lindman	*PhD, Associate Professor,* at Department of Applied IT, University of Gothenburg and consultant for OECD.	2020.03.12 70 min	Face to Face	English
Johan Magnusson	*PhD, Associate Professor,* Head of Division at Department of Applied IT, University of Gothenburg and Co-Director for SCDI.	2020.03.12 60 min	Video Call*	Swedish
Philip Prophet	*Blockchain Engineer*, at the start-up EVLedger, focusing on the decentralized Web 3.0.	2020.03.16 60 min	Face to Face	Swedish
Robert Book	*Director Blockchain Consultant* in DLT Services at CGI Business Consulting. Twenty-one years of knowledge within logistic and technology.	2020.03.27 60 min	Video Call*	Swedish

**Video Call due to Covid-19 outbreak*

Table 3.2: List of interviews blockchain experts. Compiled by authors.

AUTOMOTIVE MNC'S				
MNC	*Title/Experience*	*Date and Duration*	*Type of Interview*	*Language*
Company X	*Sustainability Manager* Global Supply Chains	2020.03.12 70 min	Video Call*	English
Volvo Cars Respondent A	*Sustainability Manager* Global Procurement	2020.03.17 60 min	Video Call*	Swedish
Volvo Buses	*Business Manager* Global Purchasing	2020.03.18 60 min	Video Call*	Swedish
Group Trucks Purchasing	*Project and Commodity Buyer* Global Purchasing	2020.03.19 70 min	Video Call*	Swedish
Volvo Group AB	*Corporate Responsibility Director* Global Supply Chains	2020.03.20 60 min	Video Call*	Swedish
Scania, Respondent a	*Strategy and Sustainability Manager* Global Purchasing	2020.03.20 60 min	Video Call*	Swedish
Volvo Cars, Respondent b	*Responsible Sourcing Manager* Global Procurement	2020.03.23 60 min	Video Call*	Swedish
Scania, Respondent b	*Digital and Information Manager* Global Purchasing	2020.03.25 60 min	Video Call*	English

**Video Call due to Covid-19 outbreak*

Table 3.3: List of interviews automotive MNCs. Compiled by authors.

3.5 Data Analysis

In order to create a valuable analysis chapter of this unexplored subject, it was found suitable to generate propositions based on the case findings. The propositions were initially based on preliminary theory, gathered before the data collection, which continuously has been confronted and adjusted to the empirical findings. Further, the empirical support of the theory has also been assessed. The propositions and continuous matching of the theory with the empirical findings have been guiding the thesis to move in the right direction (Yin, 2018).

The used analysis technique has been pattern matching (Yin, 2018), also called thematic analysis (Bryman and Bell, 2019). This analytical process started after the transcription process, were the researchers individually familiarized further with the data and the different

key points that the respondents brought up, to further adjust the propositions. The themes of the empirical findings, seen in *table 3.4* below and in the conceptual framework, were initially inspired by theory but continuously adjusted through findings in the data. Further, the authors created case-stories to find patterns, meaning that each interview was listened to and summarized in order to enhance the in-depth understanding. The transcripts of each interview were printed, revised, and coded into the themes (*table 3.4*). The procedure was made in a micro-analysis manner, thus intra-case analysis, with the purpose to extract knowledge of each case. The analysis of the transcriptions was made by the two researchers separately, in order to revise and discuss the data to enable inter-researcher reliability and reduce the risk of inaccurate conclusions. The researchers' coding differed at times, however becoming aligned after discussions to decide the final coding. This was made through the lens of the developed conceptual framework. However, remaining open-minded for the development of new themes during the data collection, e.g. the influence of bargaining power and industry collaboration in a blockchain implementation process. Meaning that there was no deliberate action to interpret the results in any direction, rather that the theory and the conceptual framework was continuously assessed, as the empirical data and understanding of the subject developed.

Themes of empirical findings		
Stages	**Themes**	**Logic reasoning**
Blockchain experts		
MNCs' compatibility with blockchain in global supply chains	- MNC motivation - MNC challenges - GSC contractual governance - GSC non-contractual governance - Blockchain facilitators	These criteria represent the limitations or opportunities that the blockchain experts' sees regarding MNCs' implementation of blockchain.
Automotive MNCs		
Current global supply chains	- MNC motivation - MNC challenges - GSC contractual governance - GSC non-contractual governance - Blockchain facilitators	These criteria represent the limitations or opportunities that the MNC's faces today and factors influencing their current supply chain state.
Perception of blockchain in global supply chains	- MNC motivation to use blockchain - MNC challenges to use blockchain - GSC contractual governance - GSC non-contractual governance - Blockchain facilitators	These criteria influence the limitations or opportunities that the MNC's interpret regarding implementing blockchain in supply chains.

Table 3.4: Themes and coding of empirical findings. Compiled by authors.

Subsequent to the coding theme development, the data was compiled based on the themes in *table 3.4* and presented in chapter *4. The Empirical Findings,* where each theme has been summarized in a table containing the main results. The main findings which led to the themes have been crystallized out of what was most logically aligned with the research question, what was seen as valuable insight in relation to the outlined purpose of the study, and what has been most frequently mentioned during the interviews. Accordingly, continuous iteration between coding, theory, and structure of findings resulted in the categorized key points in different themes, aligned with the conceptual framework and subsequently served as a basis for creating the analysis model and the developed propositions.

The empirical findings were analyzed by comparing the findings from the automotive MNCs, the blockchain experts, and the theory together with the researchers' interpretations. In order to structure the analysis, an analysis model (*Figure 5.1*, chapter 5) was constructed based on the conceptual framework and the five themes shown in *table 3.4* above. Each theme has been analyzed together in conjunction with all three stages, shown in *table 3.4*. This analysis structure and the process is the rationale of the theoretically and empirically developed propositions (chapter *5. Analysis),* of what the main barriers to implement blockchain in global supply chains are, in order to reach a conclusion and answer the research question.

3.6 Research Quality

The research quality of qualitative studies has been contested in recent years due to lacking consensus regarding what criteria to use when evaluating a qualitative study (Bryman and Bell, 2019). It is vital to ensure a high standard and Yin's (2018) suggestions to ensure trustworthiness is suitable for exploratory multiple case studies. Therefore, this study is measured by this evaluation system, divided into validity, followed by reliability.

3.6.1 Validity

The evaluation criteria validity refers to the quality of the conclusions drawn in the research to give an accurate explanation or description of the topic (Bryman and Bell, 2019; Eriksson and Kovalainen, 2014). Based on (Yin, 2018) validity is discussed in the three subcategories: construct validity, internal validity, and external validity. Firstly, in this study construct validity has been enhanced by conducting the sampling of data from multiple case companies and several experts, as well as secondary sources such as published studies in order to ensure that there are multiple appropriate sources of evidence (Yin, 2018).

Secondly, internal validity (Yin, 2018), also labeled credibility (Bryman and Bell, 2019; Eriksson and Kovalainen, 2014) is concerning the causality (Yin, 2018), meaning how well the conclusions that are drawn in the study align with the empirical findings (Yin, 2018). In this study, we have been aware that the selected findings tend to be affected by subjectivism. In order to enhance the credibility of the inferences made in this study, we as researchers have emphasized accuracy in presenting the reality. To increase respondent validation, transcripts of the interviews have been sent to the interviewees for validation to allow feedback and correction of potential misunderstandings. When needed, clarifications were done to ensure that appropriate information is extracted out of the data set. Further, both Bryman and Bell (2019) and Yin (2018) underline the technique of triangulation to increase internal validity, thus reduce the risk for author interpretation mistakes resulting from that the authors only see what is desired or predicted regarding the investigated problem. Therefore, this study carries several sources of evidence, as described in *3.4 Data Collection,* in order to ensure that validity and credibility of the research are enhanced.

Lastly, external validity (Yin, 2018), equivalent to transferability (Bryman and Bell, 2019; Eriksson and Kovalainen, 2014), is measuring whether the study is generalizable, meaning if the findings are viable in another setting. Case studies are known for being challenging to meet

a high level of external validity, as qualitative research entails a limited number of interviewees (Yin, 2018). In order to increase the external validity in this study, the sample contains the maximum number of automotive MNCs' and blockchain experts possible to tap into a wider pool of knowledge. Although, being less than intended due to the occurrence of the Covid-19 outbreak during the sampling period, which could arguably have an impact on the study's external validity. Despite a limited number of cases, the conscious decision to study automotive MNCs', rather than including broader sample size, generates a focused study more likely to be generalizable for the automotive industry (Yin, 2018). Additionally, it should be mentioned that five out of six participating companies, including six out of eight respondents in this study, are companies from two different groups. On both occasions, one or two companies are subsidiaries to the parent company, were all being large MNCs having their own respective global supply chains and global supply chain governance. However, it should be emphasized that the respondents may be influenced by the parent company's overall directive. Therefore, there is a risk of the respondents being more aligned due to some degree of interdependency than otherwise would be representative if having independent companies in the sample. This could have been reduced by having a larger sample size in order to minimize the impact of the group's responses. However, this study will contribute theoretically to the use of blockchain in global supply chains and MNCs' global supply chain governance.

3.6.2 Reliability

The reliability is an important aspect of this study and contains the two constructs of internal and external reliability to measure how well the operation of this study can be repeated with the same result (Yin, 2018). The former measures inter-researcher reliability, thus consistency between the researchers while the latter means if the results are consistent and accurate over time. In order to increase the external reliability of this study, we as researchers have been emphasizing transparency regarding the limitations, scope of the study, in the discussion of the research process and choices being made, as transparency increases reliability (Yin, 2018). Furthermore, as the topic of this thesis concerns a new fast-moving research field and constantly evolving technology that is not commonly used within companies, the respondents from the MNCs and experts may change over time. Therefore, the results from this study may differ in the future as perceptions can change, hence the study is running the risk of being obsolete in a short period of time. Since this study enables knowledge regarding the current adoption barriers in the automotive industry, it can be seen to bring the research field forward and enhance insight regarding future adoption and development, therefore it is still argued to be considered a relevant study.

Moreover, to increase the internal reliability, both researchers participated in all interviews, in the revision of all material, discussed all the transcribed interviews, as well as collaboratively performed the analysis. Simultaneously, the transcriptions, coding and the making of case-stories were done separately, and thereafter the discussion and interpretations were aligned in order to ensure inter-researcher consistency, thus internal reliability throughout the research project.

3.7 Ethical Considerations

Throughout the entire study ethical considerations have been accounted for. Meaning that already in the sampling and company selection process the topic and purpose of the study have been transparent, which is an important ethical consideration (Bryman and Bell, 2019). Accordingly, the respondents were made aware of the objectives and participated with full knowledge. In addition, the respondents were provided the possibility to remain anonymous in order to enable more transparent answers and more reliable content. However, all interviewees, except one company, agreed upon publishing company names and the respondents' area of competence. Additionally, the respondents also had the freedom to decline to be recorded before the interview started (Eriksson and Kovalainen, 2014) and the possibility to read through the transcribed interview to approve, delete, or correct content. This was considered relevant due to the perceived high likelihood of sensitive information regarding transparency in global supply chains and their blockchain advancements that companies may want to ensure that information is correctly interpreted.

4 Empirical Findings

This chapter outlines the empirical findings from the two respondent groups, the MNCs' in the automotive industry and the blockchain experts. The first part presents the findings following the order of the presented themes, which is based on the conceptual framework. The second part presents the findings by each theme but from the blockchain experts' view.

4.1 Automotive MNCs' Empirical Findings

The first section of this chapter presents the results from the six MNCs in the automotive industry. It is divided into two different parts, one part regarding the current global supply chains and the second part regarding blockchain implementation. Each part is summarized by a table containing the main results.

4.1.1 Automotive MNC's Current Global Supply Chains

In the subsequent sections the data from the automotive MNC's current global supply chain state is presented, in regard to motivation, challenges, global supply chain governance, and governance facilitators.

4.1.1.1 Motivation for Sustainability and Transparency

Having transparency is regarded to be important by all respondents in the study. All six cases agree that transparency in the supply chain mainly reaches the first-tier supplier. The need to increase transparency further is explained by multiple companies (Company X, Volvo Cars Respondent B, Volvo Buses, Volvo Group) to be on a general level for multiple purposes which varies between companies. Company X stresses that it is desired to have transparency in terms of complying with rules and regulations, while Volvo Cars, Respondent B mention that there is a need for increased openness and risk-sharing in the supply chain, meaning that transparency is necessary to accomplish that. Further, four companies (Volvo Cars Respondent A, Volvo Group, Scania Respondent B and Volvo Trucks) describe that full transparency is not needed or desired in all supply chains, as the need is to focus on specific raw materials. Volvo Trucks explain that the company is concentrating the transparency efforts towards five to ten raw materials, such as noble metals.

Regarding the MNCs' engagement in sustainable supply chains, all companies express it to be highly important. Most of the companies (Company X, Volvo Cars, Volvo Buses, Volvo Group and Scania) say that the motivation is based on external stakeholder pressure, primarily by customer demand, legal concerns, and societal pressure. However, there are also internal drivers as motivation towards sustainability. Company X says that motivation is grounded on the responsibility for sustainable development and emphasizes the importance of environmental and social compliance in supply chains and risk management connected to sustainability. Regarding Volvo Cars, both respondents state that the company's internal motivation to engage in sustainable supply chains is stemming from managers' and employees' interest. Volvo Cars respondent A states that it is necessary to engage in sustainable supply chains to survive as a business. However, both respondents for Volvo Cars states that

sustainable supply chains are crucial to maintain brand profile and reputation. Concurrently, Volvo Cars respondent B emphasizes the need to be able to respond to questions in media, particularly regarding the mining of certain raw materials. Moreover, Volvo Buses describes their motivation for sustainable supply chains to be driven by company values, pure human motivation, and emphasize the need for will power in order to find sustainable solutions for supply chains. The company explains the motivation to be business-driven by expressing:

> *"In addition to the purely human motivation to contribute to a better society, it is also business-driven. Customers are increasingly demanding a sustainability approach and we need to meet their expectations."*
> *- Volvo Buses*

Similarly, Volvo Group explains that people and the environment are core values to engage in sustainable supply chains. Both respondents at Scania states that sustainable supply chains are core in their business and that they are aiming to be at the forefront in this field, for example regarding environmental, health, and safety aspects as emphasized by Respondent A in Scania. Volvo Trucks also expresses the desire to take the lead on innovations and stress this as the main factor to engage in sustainable supply chains as it is necessary in order to have a sustainable product, enhance supplier relationships and supply chain management. Overall, proactive actions and over compliance to rules and regulations are part of the majority of the companies' (Company X, Volvo Cars Respondent B, Volvo Group and Volvo Trucks) motivation for sustainable supply chains as this is necessary to cope with future changes. In addition, Volvo Trucks explain this as being important for their strategy and that it is driven by their desire to be at the forefront as a company.

MNCs' current state: Summary of motivation for sustainability and transparency						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Transparency						
Transparency for multiple purposes	✓	✓	✓	✓	✗	✗
Transparency for specific raw materials	✗	✓	✗	✗	✓	✓
Sustainability						
External stakeholder pressure	✓	✓	✓	✓	✓	✗
Over compliance to laws	✓	✓	✗	✓	✗	✓
Managers/employees' interest	✗	✓	✓	✗	✗	✗
Brand profile and reputation	✗	✓	✗	✗	✗	✗
Risk management purposes	✓	✓	✗	✗	✗	✗
Sustainable innovation trend	✗	✗	✗	✗	✓	✓
✓*=Agrees,* ✗*= No comment*						

Table 4.1: Summary of MNCs' motivation for sustainability and transparency.
Complied by authors based on empirical findings.

4.1.1.2 Challenges in Global Supply Chains

Five of the six companies (Company X, Volvo Buses, Volvo Group, Scania, Volvo Trucks) mention that one of the major challenges in their global supply chains is the inherent complexity in the networks. Further, all MNCs' mention social sustainability concerns such as human rights and minimum wages in lower-tier suppliers as a global supply chain challenge.

Volvo Cars Respondent B says that many of the social sustainability risks are due to lacking lower-tier governance, as suppliers in the supply chain lack the knowledge on how to govern sub-suppliers. According to Volvo Group there are geopolitical differences in standards and laws which complicate the supply chains, although it is acknowledged that it is in the lower tier suppliers that the violations to their policies and regulations that occur.

Further, Volvo Buses mention that the complexity is increased as many products contain cross-industry components. As expressed by Scania, Respondent A prior to the Covid-19 outbreak they did not know exactly what the upstream supply chain looked like in China. However, Volvo Buses starts with explaining that they are experiencing difficulties in reaching second and third-tier suppliers due to the complexity and lack of visibility resulting from an immense number of suppliers in the supply chain being up to 10.000 for the company. Therefore, Volvo Buses says that they aim to increase transparency by using IT tools. However, the complexity in their automotive supply chain is limiting the ability to have a transparent supply chain. Scania Respondent B explains that they perceive the lack of transparency being due to first-tier suppliers seeing it as a competitive edge not sharing their sub-suppliers. It is also mentioned by Company X that although large efforts are made to increase knowledge of sub-suppliers, it is difficult to get further upstream than to four or fifth tier suppliers.

There is consensus amongst the companies that reluctance to share information within the supply chain, is one of the greatest challenges. This is a mutual concern, both from the MNCs and the supplier end. The first is related to not been given a sufficient amount of information, while the latter is explained by two companies (Company X and Volvo Trucks) that there is a risk to share data with external parties as information may be exploited, thus making the company reluctant and selective with who they share data. Moreover, Scania, Respondent B emphasize the need for information in order to make fact-based decisions and evaluate risks. This is in accordance with Volvo Buses who says that there are such low levels of information from suppliers that they need to have blind trust in the suppliers and express that lack of information sharing is leading to whiplash effects in the supply chain. Volvo Cars Respondent A says that for some components the company has one supplier, exemplifying a high dependency on that one supplier. Whereas, Volvo Trucks agrees that the supply chains are fragile, especially seen during the Covid-19 outbreak. The respondent further explains that even with full information it is difficult to alter the supply chain as the supplier selection process is extensive, meaning that it is time-consuming to switch suppliers if problems occur:

"We are very susceptible to changes, stops, and various interruptions in the supply chain. There are no buffers and nothing to work with if something goes wrong and it doesn't take many weeks before it turns problematic..."
- Volvo Trucks

MNCs' current state: Summary of challenges in global supply chains						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Complex supply chains	✓	✓	✓	✓	✓	✓
Social sustainability concerns	✓	✓	✓	✓	✓	✓
Lack of information sharing	✓	✓	✓	✓	✓	✓
High dependency on suppliers	✗	✓	✗	✗	✗	✓
✓= *Agrees,* ✗ = *No comment*						

Table 4.2: Summary of MNCs'challenges in global supply chains. Complied by authors based on empirical findings.

4.1.1.3 Governance in Global Supply Chains

The global supply chain is governed by measures divided into contractual and non-contractual activities. The results are presented in each respective category in this section.

Contractual governance

When asked about the companies' evaluation system, all six companies express that they use an auditing system and that they have a standardized system based on guidelines, self-assessment questionnaires, and established code of conduct with their first-tier suppliers. As described by Volvo Trucks, Volvo Cars, and Volvo Group, the initial screening process is based on several criteria, primarily containing price, quality, sustainability. At the same time, three companies (Volvo Cars Respondent A, Volvo Trucks and Volvo Group) express the long and time-consuming process when evaluating suppliers. Volvo Group mentions that they have limited resources available for evaluating suppliers, as procurement teams are overwhelmed by evaluation processes and the respondent express the following:

> *"It should be easy for commodity buyers to evaluate suppliers, but they have so much to do. We are aiming to bring sustainability evaluation naturally into the work processes, which is a challenge."*
>
> *-Volvo Group*

Moreover, all MNCs' describe that they have contracts with the first-tier suppliers, meaning that they are able to influence and implement desirable standards to the first-tier suppliers, but do not hold accountability beyond the first-tier. As described by Volvo Cars, in the contractual agreements with the first-tier suppliers, it is stipulated that the first tier, in turn, should govern their suppliers. Adding upon that, Volvo Trucks explains the process of governing upstream suppliers still has to be in conjunction with the first-tier supplier. Company X mentions that smaller approaches are made towards the second and third-tier suppliers. Further, Volvo Cars Respondent B mentions that they are aiming for multi-tier governance. However, the company explains that lack of transparency complicates the sub-supplier governance, by expressing:

> *"...one month a supplier could buy from a specific lower tier supplier and the next month from another, as they got a better price. This makes it pretty hopeless to keep track of suppliers in the chain."*
>
> *- Volvo Cars, Respondent B*

Further, four companies (Volvo Cars Respondent A, Volvo Buses, Volvo Group, and Volvo Trucks) stress that governing lower-tier suppliers is excessively resource consuming. Volvo Trucks describes that governance is also expensive, but at the same time, the company needs

the necessary information. Volvo Buses explains further that there is a lack of control systems regarding for example conflict minerals. Volvo Cars Respondent B claims that strict governance and control leave no room for supplier underperformance which is an important factor for the company. Similarly, Volvo Trucks say that when there are limitations in trust, contractual agreements are needed. Related to difficulties in governing the global supply chain, Volvo Buses describes that the larger the geographical distance, the more governance is needed.

When discussing audits, all companies in the study conduct the majority of audits by using a third-party actor. This is explained by the Volvo Group being important as there is a standardized system in the industry, meaning that this is more efficient for the suppliers required to conduct one assessment only. The company describes further that the third-party ensures that the suppliers' and MNCs' information are not spread, which, in accordance with competition law, prohibits that confidential data is shared between parties. Volvo Trucks explains that the third party contributes to increased legitimacy, credibility, trust between the MNC and the supplier and decreases the risk of suppliers acting in self-interest. Moreover, five of the MNCs' (Company X, Volvo Cars, Volvo Group, Scania, Volvo Trucks) mention that they are increasingly aiming to conduct audits upstream the supply-chain on certain raw materials that they perceive to be crucial in terms of sustainability concerns. Volvo Trucks describes that there is an incremental increase in sustainability claims meaning that the need and resources for auditing are increasing further.

Non-contractual governance

Aligned with the contractual governance, all companies state that non-contractual governance is primarily directed towards the first-tier suppliers, which subsequently build relationships with their suppliers upstream the supply chain. When discussing supply chain interconnections, all companies have a similar understanding of the high importance of relationships upstream the supply chain in order to have a well-functioning supply chain governance. However, all companies have somewhat differing views on non-contractual governance. Company X describes the collaboration with upstream suppliers to be dependent on supplier interest, which is in accordance with Scania Respondent A, meaning that supplier interest is part of deciding the level of collaboration. Also, Company X adds that if it is a supplier that they label 'hotspot' supplier, it is of extra importance to the company. Thus, this will raise the collaboration between the parties. At the same time, Company X experience that both first and second-tier suppliers are lacking interest in transparency and traceability. Volvo Cars Respondent A says that it is important to have a long-term goal and extensive communication with the supplier in order to increase collaboration. Whereas Volvo Cars Respondent B and Volvo Group explain that their top management is needed to be involved in order to address critical aspects in the supply chain and to show seriousness from the MNC's side. Further, Volvo Cars, Respondent B explains that they chose the 20 largest suppliers to receive the most attention and build a long-term collaboration. Also, Volvo Cars Respondent B adds that to only have trust is not sufficient, but at the same time trust between the MNC and the supplier decreases the use of resources due to diminishing governance costs.

Volvo Buses states that trust is fundamental and enables the possibility to build a relationship in the first place. Consequently, it is the relationships that enable increased information flow. The importance of collaboration and partnership is expressed by Volvo Buses, as the potential in collaboration and product development is a deciding factor when choosing suppliers. Volvo Buses further describe that with specific suppliers they might share information as well as profits on product development collaborations. Similarly, Scania expresses that first-tier collaboration is important in product development. Regarding development, Volvo Group says that communication and collaboration are essential to address social sustainability and implement new systems in the supply chain network. Similarly, Volvo Trucks says that trust is essential to build inter-organizational systems in the supply chain. Volvo Group further states that in addition to openness, honesty and transparency, supply chain relationships are important for the company's supply chain risk governance. Also, Scania describes that working together with their first-tier suppliers, in terms of training and education projects create good relationships. However, Scania Respondent B further explains that they need to rely on the information, for example regarding the content in certain products, that they receive from suppliers and therefore the relationship is built upon trust.

"We need to rely on the information we get from our suppliers, e.g. from our material datasheets. This type of information is, of course, quite limited as we need to trust our suppliers."

- Scania, Respondent B

Aligned with Scania, Volvo Trucks say that provenance is currently established through trust. However, the company further states that more guarantees are needed in the relationship as the suppliers at times have incentives to provide faulty information. At the same time, Volvo Trucks explains that it is time - and resource consuming to establish good relations and evaluate if the information from the suppliers is reliable, which creates a need for an integrated system that all parties can find trustworthy.

MNCs' current state: Summary of global supply chain governance						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Contractual governance						
Use standardized first-tier contracts	✓	✓*	✓	✓	✓	✓
Resource consuming to evaluate first tier	✗	✓	✗	✓	✗	✓
Resource consuming to govern lower tier	✗	✓	✓	✓	✗	✓
No responsibility beyond first tier	✓	✓	✓	✓	✓	✓
Use third party audits on first tier	✓	✓	✓	✓	✓	✓
Use audits for crucial raw materials	✓	✓	✗	✓	✓	✓
Non-contractual governance						
Relationship directed towards first tier	✓	✓	✓	✓	✓	✓
Collaboration dependent on suppliers	✓	✗	✗	✗	✓	✗
Important to minimize resources spent	✗	✓	✗	✓	✗	✗
Product development with suppliers	✗	✗	✓	✗	✓	✗
System development requires trust	✗	✗	✗	✓	✗	✓
✓= *Agrees,* ✗ *= No comment,* * *= Multi-tier contract and relationship in one chain*						

Table 4.3: Summary of MNCs'governance in global supply chains. Complied by authors based on empirical findings.

4.1.1.4 Governance Facilitators in Global Supply Chains

Bargaining power

Regarding the perceived bargaining power, four companies (Company X, Volvo Cars, Volvo Group and Volvo Trucks) state that they have a strong negotiation position in the supply chain. At the same time, the majority of the companies (Company X, Volvo Buses, Scania, Volvo Trucks) state that it is dependent on the company size and the volumes at hand. Company X and Volvo Cars state that they have a high ability to put demands on the supplier, and Company X says that they specifically have strong bargaining power with their first-tier suppliers. Volvo Buses says that they have a larger influence dependent on the supplier's interest in future business opportunities and mention that sometimes they use the entire corporate group in negotiations, in order to increase bargaining power. This is also described by Scania as they use the corporate group to negotiate in certain products. Also, despite that Volvo Group perceive their bargaining power with suppliers as large, the company states that in certain cases one company can not influence the suppliers. In contrast, Volvo Cars, Scania and Volvo Trucks express their bargaining power as being able to have a 'either you are in or you are out' pressure in the negotiation with their suppliers, however also being dependent on the commodity. However, Volvo Cars Respondent A also speaks of the difficulties in changing suppliers in the supply chain, meaning that even if suppliers do not comply with their demands they are not able to change and therefore the negotiation with existing suppliers is essential.

Industry collaboration

All companies have a positive attitude towards industry collaboration and a majority of the companies are taking part in intra-industry initiatives, at the same time describing difficulties to select what initiatives to be part of. Three companies (Company X, Volvo Cars and Scania) describe this being dependent on input and output, thus that clear incentives are required for participation. This evaluation process is described by Volvo Cars Respondent A to be highly resource consuming. Also, two companies (Company X and Scania) mention that industry collaboration increases transparency, where Company X express the following:

> *"Transparency projects conducted with first-tier suppliers or other bilateral exchanges, or industry exchanges are important in order to collect information to reach higher transparency."*
>
> *-Company X*

Company X further express that they often collaborations on a group level and has supplier ratings and assessments where these kinds of initiatives benefits learnings and knowledge. Moreover, Company X express that a wide industry collaboration is needed to clearly outline expectations and use market power to promote standards for the industry at large. Therefore, Company X and Scania Respondent A, express that a global approach is preferred as interregional standards and knowledge are required to create practically applicable standards for all companies as the industry and the supply chain are located globally. Similarly, Volvo Cars has a positive view on common industry standards for auditing the suppliers as this minimizes the resources spend and might be important to established industry-wide goals.

Unlike the other companies, Volvo Cars Respondent A mentions a negative aspect with industry collaboration, meaning that the negotiation process to established standards slows

down the standardization process. Volvo Buses see industry collaboration in an information-sharing perspective, meaning that competing companies can collaborate to share information regarding traceability upstream the supply chains. However, it remains crucial that no confidential information is shared in the collaboration, as three companies (Volvo Buses, Volvo Trucks and Scania), emphasize that there might be risks regarding open communication. In contrast, two companies (Volvo Group and Scania) state that inter-industry collaborations regarding lower-tier suppliers might be needed to share knowledge and increase power as automotive suppliers operate on a cross-industry level. This is seen as useful, as Scania express a distinction between collaborations in a competitive and non-competitive scope, meaning that cooperation is possible for the concerns outside where companies differentiate. At the same time, Scania Respondent A states that the value of collaborating is sometimes more important than their own needs:

"Usually the value of doing something together is greater than the value of not doing anything at all, so you can often, as a company, accept that it may not be exactly what you want"

- Scania, Respondent A

MNCs' current state: Summary of governance facilitators						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Bargaining power						
Dependent on company size and volumes	✓	✗	✓	✗	✓	✓
Have strong bargaining power	✓	✓	✗	✓	✗	✓
Have bargaining power as a group	✗	✗	✓	✗	✓	✗
Use coercive negotiation on some products	✗	✓	✗	✗	✓	✓
Industry collaboration						
Have a positive attitude	✓	✓	✓	✓	✓	✓
Participation is dependent on incentives	✓	✓	✗	✗	✓	✗
Have positive influence on transparency	✓	✗	✗	✗	✓	✗
Prefer collaboration on a group level	✓	✗	✗	✗	✗	✗
Prefer collaboration in global initiatives	✓	✓	✗	✗	✓	✗
Negotiation slows down processes	✗	✓	✗	✗	✗	✗
Enables sharing of resources to reach traceability	✗	✓	✓	✗	✗	✗
Reluctant to share business critical information	✗	✗	✓	✗	✓	✓
Cross industry collaboration governs upstream suppliers	✗	✗	✗	✓	✓	✗
✓=*Agrees,* ✗= *No comment*						

Table 4.4: Summary of MNCs' governance facilitators. Complied by authors based on empirical findings.

4.1.2 Automotive MNC's Global Supply Chains and Blockchain

In this section, which is the last part of the results from the automotive MNCs', the data regarding their view upon implementing blockchain will be outlined.

4.1.2.1 Motivation to use Blockchain in Global Supply Chains

In general, there are fairly low levels of knowledge amongst all respondents regarding blockchain. However, Volvo Cars have implemented blockchain in March 2020 in the supply

chain of one raw material, namely cobalt. Further, Volvo Cars Respondent B states that they are the first company to implement blockchain in the automotive industry. In contrast, Volvo Buses says that they are unsure if or when blockchain could be adopted in their company. Further, three companies (Company X, Volvo Group, Scania) have pilot projects and are experimenting with the technology to reveal what value blockchain could bring to their specific company. This is done in regard to chains of critical raw material and Company X mentions specifically that this is done with an external party to gain knowledge. Similarly, Volvo Cars explain that the pilot project they did prior to the implementation was also with an external actor, as well as the actual implementation. Volvo Cars describe their motivation like this:

"...our sustainability team expressed the need and will to create a transparent supply chain for the batteries in our car production. That was the start towards implementing blockchain, and today we are keeping track of each step in the cobalt supply chain"

-Volvo Cars, Respondent B

The difference in the respective companies' current level of blockchain implementation and the achieved level of transparency is visualized in the figures below. However, representing one supply chain, not representing the companies' overall supply chain transparency.

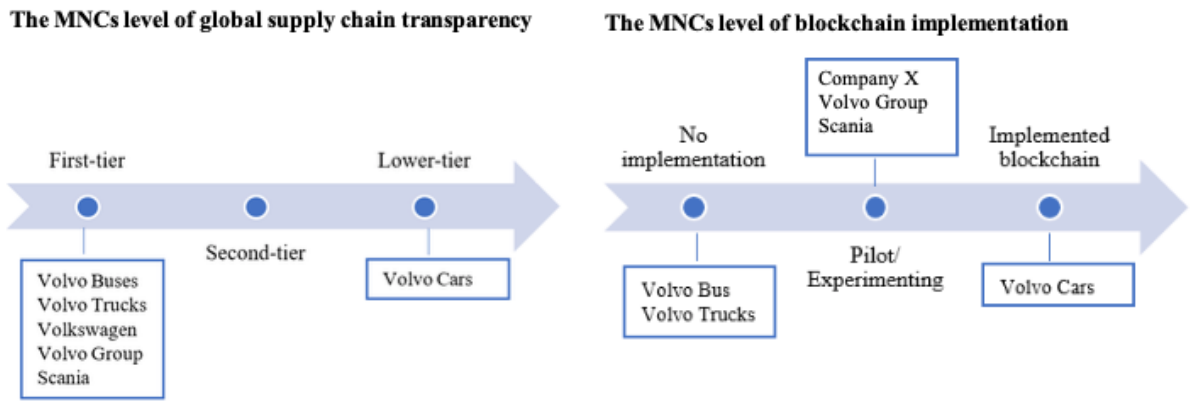

Figure 4.1: The automotive MNCs' level of blockchain implementation and transparency in the cobalt supply chain. Compiled by authors based on empirical findings.

There is a consensus amongst the respondents that one major motivation to implement blockchain in supply chains is to increase traceability to enhance transparency. Yet, companies' motivation is driven by different underlying factors. The majority of the companies (Company X, Volvo Cars, Scania and Volvo Trucks) say that blockchain enables more efficient audits in the supply chain, which contributes to the MNCs' ability to evaluate the suppliers. In regard to audits, Company X believes blockchain enables the verifiability of the information in the supply chain. Volvo Cars state that blockchain makes the audit process more resource efficient. However, it also states that knowing the origin of a product might, in fact, eliminate the need for audits. Scania Respondent B explains that blockchain would be a self-auditing control system for the company, which leads to the ability to identify bottlenecks and minimize risks in order to ensure their material flow in the supply chains. Volvo Trucks explains that blockchain-enabled audits would be cheaper, as it reduces the number of audits by an external third party and is a framework enabling trust, which enables the supply chain actors to share information and data without risks for fraud.

Company X and Volvo Cars say that blockchain increase the control of the material flow. Volvo Buses express that it would be good to increase the reliability of information from specific important materials. Whereas, Volvo Trucks believes that blockchain would establish information about material origins, which could increase the internal efficiency processes as they have limited resources for today. Further, both respondents from Volvo Cars explain that transparency upstream the supply chain is crucial as it is important to ensure social sustainability, such as no child labor, in critical supply chains. Subsequently, the company wants to publish the origin of the material to stakeholders. Similarly, Scania Respondent B, mention that stakeholder pressure is contributing to their motivation to use blockchain to ensure the sourcing of material from conflict-free regions. Volvo Group explains that the reliability of information is needed to increase knowledge of provenance and to be able to influence suppliers beyond tier one and tier two. Similarly, Scania Respondent A says that a multi-tier information system providing information that they do not have today is required as a basis for decision-making, which increases the possibility to take action. Further, Scania Respondent B describes blockchain to be a tool for efficient supply chain documentation in an immutable manner:

"Blockchain is sort of a highlighted example on data management, and it can help us with the data".
- Scania, Respondent B

MNCs' perception: Summary of motivation to use blockchain						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Level of implementation	pilot	SC	✗	pilot	pilot	✗
Gain transparency/traceability due to:	✓	✓	✓	✓	✓	✓
- Sustainability purposes	✗	✓	✗	✗	✓	✗
- Stakeholder pressure	✗	✓	✗	✗	✓	✗
- Enhance efficiency in audits	✓	✓	✗	✗	✓	✓
- Retrieve reliable information	✗	✗	✓	✓	✗	✗
- Multi-tier info to decrease risks	✗	✗	✗	✗	✓	✗
- Increase control of material flow	✓	✓	✗	✗	✓	✗
✓=Agrees, ✗= No comment, SC= Supply chain, pilot = pilot, SC = implemented in one SC						

Table 4.5: Summary of MNC's motivation to implement blockchain. Complied by authors based on empirical findings.

4.1.2.2 Challenges to use Blockchain in Global Supply Chains

When discussing the companies' challenges to use blockchain technology in their respective supply chains, Company X says that there is a lot of talking about blockchain technology in general. However, the company has a limited knowledge of blockchains impact, value creation, and use cases, also in accordance with Volvo Buses, Volvo Group, Scania, Volvo Trucks.

When asked about sharing information with suppliers, Volvo Buses state that it is not open to sharing information with suppliers as this could spread to competitors. Volvo Group state that everything should not be traceable, meaning that the right to privacy in regard to ethical aspects is important and highlight the concern that blockchain technology could be used in the wrong

manner. Scania Respondent A describes that the protection of competitiveness in collaboration and information sharing when conducting business is essential and state:

> *"The right person or entity should be able to see the right information, but not all information. Having everything open becomes a restriction on trying to do business in competition with others."*
>
> *- Scania, Respondent A*

Prior to implementation, Respondent A from Scania expresses that legal and governance aspects need to be considered and worked out. Scania Respondent B explains that it is difficult to estimate the amount of effort and what challenges that lie ahead and Scania Respondent A mention that they perceive that there is an organizational immaturity in order to adapt the blockchain technology. Also, the technology itself is immature and has to be further standardized prior to potential implementation. The technological immaturity is also mentioned by Volvo Buses and Volvo Trucks. Although having the perception that it is an interesting technology, Volvo Buses describes that they will not take the lead in blockchain implementation and Scania Respondent B refers this to something being implemented by the passenger car side of the automotive industry first. Additionally, Volvo Buses and Volvo Group and Volvo Trucks express hesitancy towards blockchain in general, arguing that it might not be the full solution for transparency in supply chains, either to reach sustainable supply chains, nor being a first step in the solution towards establishing trust and enhanced supply chain relationships.

Furthermore, Volvo Cars express that there are resistance organizations among the mining companies due to the unwillingness to share the origin of their material. This is explained by the fact that mines that do not have child labor may purchase from mines who have child labor and therefore being unwilling to be part of a blockchain network increasing transparency. Volvo Buses state that a challenge is that suppliers with nothing to hide have to participate in the blockchain. Related to the unreliability of suppliers, two companies (Company X and Scania) describe that the difficulty to ensure that the data input is correct in the initial stage of the chain and to be able to trust the information is one challenge creating reluctance for them.

Unlike the other respondents that emphasize the supplier perspective, Volvo Trucks says that the MNCs need incentives to invest in a system like a blockchain. Meaning that if a company risks being fined for using certain material in the production and perceives high customer demand or already having a well-functioning supply chain system, the incentives to use blockchain technology decreases. Moreover, Volvo Buses describe that supply chains are not a static environment due to continuous changes of components in the supply chain, which subsequently hampers blockchain implementation. Similarly, Volvo Cars state that blockchain is not meant to be implemented in all supply chains as this would be impractical. Therefore, the company states that it will be used where it is needed the most, in a few specific supply chains:

> *".. it (blockchain) will be used for nickel, lithium, mica and earth metals, typical materials that cause human rights abuses or severe interference with both animal and human well-being."*
>
> *- Volvo Cars, Respondent B*

Volvo Cars explain that the implementation process is highly time and resource-consuming due to lacking supply chain transparency and understanding. Meaning that firstly, the participants in the supply chain had to be figured out. Secondly, the focal suppliers were lacking understanding and knowledge related to the questions and subjects needed to facilitate implementation. According to Volvo Cars, it is difficult to implement blockchain in already established supply chains and easier to implement when sourcing new material. Volvo Group is aligned with the view that it can be costly to implement blockchain. Moreover, Volvo Cars says that top management is needed in the supply chain network negotiation process in order to convince and motivate the suppliers. Regarding internal aspects, the company had underestimated the magnitude of efforts needed to onboard the organization, make appropriate investments and changes in the production facilities. Simultaneously, Volvo Buses state that it is time-consuming to establish new working processes prior to standardization.

MNCs' perception: Summary of challenges to use blockchain						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Unclear business value	✓	✗	✓	✓	✓	✓
Difficult to verify data input	✓	✗	✗	✗	✓	✗
Not suitable for all supply chains	✗	✓	✓	✗	✗	✗
Resource consuming to implement	✗	✓	✓	✓	✗	✗
Risk for information exploitation	✗	✗	✓	✓	✓	✗
Technology perceived as immature	✗	✗	✓	✗	✓	✓
Uncertainty towards blockchain	✗	✗	✓	✓	✗	✓
✓ = *Agrees,* ✗ = *No comment*						

Table 4.6: Summary of MNCs challenges to implementing blockchain. Complied by authors based on empirical findings.

4.1.2.3 Governance Changes with Blockchain

This section presents findings regarding blockchain-enabled changes within MNCs' supply chain governance, divided into the subsections contractual and non-contractual activities.

Contractual governance

When discussing blockchain with the respondents, half of the companies had opinions and views on effects by blockchain in the supply chain network in terms of contractual governance. Three companies (Company X, Volvo Buses and Volvo Group) did not mention specific perceptions regarding possible impacts. At the same time, Volvo Cars Respondent A says that third party auditing is needed, also with blockchain implemented in the supply chain network. The third-party auditor is facilitating the governance of material flow and ensures the authenticity of the data input to the blockchain system, a challenge previously discussed. Volvo Cars Respondent B further explains that blockchain technology can use face recognition, bar codes, GPS coordinates, chips and other technology functions connected to the material traceability system, making it a secure incorruptible system. When the material exceeds the expected place and scanned weight in the manufacturing process an alarm set off, where Volvo Cars explains further:

"We notice right away if someone is trying to manipulate the system and bring in some other material on the side. Then the blockchain system starts an alarm! We get alarms when it is the wrong quantity, the wrong place or takes a different long time from one process to another..."

- Volvo Cars, Respondent B

Regarding the design of the contracts related to blockchain, to enable suppliers to onboard the blockchain network, Volvo Cars Respondent B explains that there are different interfaces and information limits applied to the different actors (nodes) on the blockchain. Meaning that the blockchain is regulated and designed to ensures all parties' interests, eg. Volvo Cars has full visibility in the supply chain. Regarding visibility, Scania Respondent A states that there is a need for a control system that may ensure that the suppliers in the supply chain are following its expected standards of human rights and environmental footprint in the supply chain. Further, Scania Respondent B says that blockchain enhances efficiency in transactions, thus decrease paper documentation between suppliers which would facilitate the business. Volvo Trucks says that a technology such as a blockchain can enable a framework that allows for increased trust which subsequently drives the business further between parties in the supply chain network.

Non-contractual governance

When asked about supply chain network changes, Volvo Cars Respondent B state that in order to succeed with blockchain implementation, the relationships are crucial. In detail, top management needs established relationships primarily with the first-tier peers, as the second-tier supplier is approached through the first-tier supplier. Both respondents in Volvo Cars mention that blockchain enhances collaboration and relationships as the actors work together towards a common goal.

However, the majority of the companies (Company X, Volvo Cars, Volvo Buses, Volvo Group and Scania) state that suppliers need incentives to commit to a blockchain implementation, which is perceived as an obstacle. Company X explains that suppliers can not be forced to participate in the blockchain, although this could be enhanced by eg. market pressure. However, three companies (Volvo Cars Respondent B, Volvo Group and Scania) state that suppliers might have an unmotivated suspicion towards releasing information and that the suppliers are lacking business interests to join. In order to solve this problem, Volvo Cars created incentives and shortened the implementation process, as the company is funding the first year of blockchain technology usage. In contrast, Volvo Group stresses that regulations or a strong relationship are a prerequisite to creating supplier incentives to join the network. Also, Scania stresses that suppliers lack the knowledge and technical infrastructure needed to collaborate on a blockchain network with the company.

In addition, once the suppliers understand the advantages of blockchain, it positively influences the supplier's business. It is described that being part of the blockchain network gives benefits in comparison to other suppliers, thus creating a competitive advantage. Similarly, Volvo Buses says that blockchain-enabled traceability leads to greater trust and consequently enhanced relationships. Also, increased trust and transparency lead to reliability on the material and confidence that the supplier supply what is demanded from the company. This is in accordance with Scania Respondent A stating that increased information flow is key to ensure traceability

and reliability in the components being delivered from the suppliers. Volvo Buses explain that this reduces the amount of guessing that currently occurs in the governance of supply chains today.

At the same time, Volvo Buses state that blockchain would decrease the need for relationships, as information flow facilitates the negotiation process both for the customer and buyer, which enables efficient business in the supply chains. Further changes in the supply chain are described by Volvo Cars Respondent A to be a possible consolidation of the supply chain as it reduces the number of unreliable suppliers in the supply chain. Scania, Respondent B says that blockchain-enabled transparency leads to better relationships, supplier development and knowledge of risks in the supply chain. In contrast, Volvo Group expresses that it believes that blockchain will influence the relationships in the supply chain. While it is unclear exactly how, the company believes that blockchain still needs to be complemented with supply chain collaboration in order to influence the overall company, supply chain and global sustainability goals.

MNCs' perception: Summary of governance changes with blockchain						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Contractual governance						
Decreased third party auditing	✗	✓	✗	✗	✗	✗
Safe multi-tier material traceability system	✗	✓	✗	✗	✗	✗
Customized design for participants*	✗	✓	✗	✗	✗	✗
Facilitate inter-organizational transactions	✗	✗	✗	✗	✓	✓
Non-contractual governance						
Top managers needed to convince suppliers	✗	✓	✗	✗	✗	✗
Suppliers need incentives to join	✓	✓	✓	✓	✓	✗
Consolidated supply chains	✗	✓	✗	✗	✗	✗
Enhanced business for suppliers'	✗	✓	✗	✗	✓	✗
Increased trust and relationship	✗	✗	✓	✓	✓	✗
✓ = *Agrees,* ✗ = *No comment, *Permissioned blockchain*						

Table 4.7: Summary of MNCs' governance changes with blockchain. Complied by authors based on empirical findings.

4.1.2.4 Blockchain Implementation Facilitators

Bargaining power

In regard to bargaining power, Volvo Cars, Respondent B says that it is crucial to be able to choose the participants to the blockchain implementation based on certain pre-set criteria, and this would more or less automatically outline a sample of sustainable suppliers. At the same time, it is described that bargaining power and large volumes are needed to create incentives to onboard suppliers. However, Volvo Cars Respondent A states that suppliers with a specific product might not want to join the blockchain network, meaning that it is more difficult to onboard niche suppliers due to less bargaining power. Scania Respondent A emphasizes the need to use influence on suppliers to push them towards the desired direction and that both coercive power and incentives methods have to be used. Volvo Trucks state that bargaining power is needed for implementation and that negotiation in a coercive manner is likely to be

necessary as an ‘in or out’ negotiation would shove the suppliers towards adjusting to the company’s contracts.

Industry collaboration

Four of the companies in the study (Volvo Cars, Volvo Buses, Volvo Group and Scania) mention that inter-company collaboration in blockchain implementation is necessary to increase value. While Volvo Cars, Volvo Buses and Volvo Group are positive to industry collaboration, Scania is positive to have a collaboration on a group-level. Volvo Cars Respondent B state that there is a need to share supply chain risks and costs particularly for the sourcing of critical materials, meaning that the automotive industry needs to invest in specific mines as a group. Volvo Cars Respondent A explains that a long-term perspective on organization-wide collaboration is important. The company explains that industry agreements and standardization on supplier requirements would decrease the administrative burden in governance and would crystalize what suppliers that are sustainable and follow agreements.

Volvo Buses says that industry collaboration is necessary, as suppliers can not have different blockchains that are not interoperable and compatible. Therefore, competitors need to cooperate and develop a common system, as a standardized system is a key to develop transparency. To succeed, Volvo Buses says that they need to negotiate and compromise on the claims they have. However, if traceability is achieved it might be good enough. Similarly, Scania, Respondent A says that the blockchain implementation requires a negotiation process where all participants’ needs are satisfied. At the same time, Volvo Buses state that this is a time-consuming process and the automotive industry is a conservative industry needing a lot of customer pressure.

Volvo Cars and Volvo Group argue for industry collaboration, country- and stakeholder-wide initiatives in order to increases resources to tackle geopolitical problems in the supply chains. On the other hand, Volvo Cars Respondent A says that confidential information decreases the rate of standardization in the automotive industry. Also, both respondents in Scania say that standardization has to established by the cross-industry and vertical collaboration to increase accountability. Also, Scania says that it is important to conceal information regarding their supply chain networks, such as numbers, volumes, the identity of suppliers, and sub-suppliers. Business-critical information and information that differentiate the company from its competitors is sensitive data, meaning that the company is selective in what to share with other parties. In addition, Scania Respondent B says that knowledge, new connections, and information sharing are important and that this is something the company does on a group-level, meaning that non-competitive industry collaboration is preferred.

MNCs' perception: Summary of blockchain implementation facilitators						
Results	Company X	Volvo Cars	Volvo Buses	Volvo Group	Scania	Volvo Trucks
Bargaining power						
Enables selection of suppliers	✕	✓	✕	✕	✕	✕
Bargaining power and volumes needed	✕	✓	✕	✕	✓	✓
Industry collaboration						
Required for implementation	✕	✓	✓	✓	✕	✕
Collaboration on group level required for implementation	✕	✕	✕	✕	✓	✕
Intra-industry investments needed for specific materials	✕	✓	✕	✕	✕	✕
Standardizations required for long-term perspectives	✕	✓	✓	✕	✕	✕
Standardizations requires negotiation process	✕	✕	✓	✕	✓	✕
Cross-industry collaboration needed to create impact	✕	✓	✕	✓	✓	✕
Reluctant to share business critical information	✕	✕	✕	✕	✓	✕
✓ = *Agrees,* ✕ = *No comment*						

Table 4.8: Summary of MNCs' blockchain implementation facilitators. Complied by authors based on empirical findings.

4.2 Blockchain Experts Empirical Findings

The second section of this chapter presents the empirical findings from the blockchain experts, and their view upon MNCs' barriers to blockchain, where each part is summarized by a table containing the main results.

4.2.1 Motivation to use Blockchain Technology

Blockchain-enabled functions

The blockchain technology is argued to be the most transformative technique and will change the world, according to Prophet. Except for general main functions that blockchain provides, which are already well established in the field of blockchain technology, include trust, tamper-proof system, security, incorruptible, there are also other enablers of the technology, as expressed by Lindman, Prophet, and Book. Lindman and Book argue that blockchain technology may be driving digitized transactions. Lindman further states that it enables logging in the digital realm. In fact, Book explains that blockchain technology can be built to verify in and outflows which are recorded by a monitoring system. Book further emphasizes that an important feature of blockchain technology is that it is an infrastructure:

> *"The blockchain in its foundation is basically like a black box, it's an infrastructure."*
>
> *- Book*

Moreover, Lindman explains that this infrastructure allows for several design choices and design trade-offs dependent on the needs of the company or community. According to Prophet, the design choices may limit visibility although maintaining the verifiability of information as information may be encrypted and not visible unless the other party has a key to decrypt it. Further, Prophet explains that the content may be shared with only selected parties on the chain despite that it is on a public, permissionless blockchain, open for anyone. Magnusson agrees and stresses that no one can see what you do not want them to see. In addition, Book claims that the actors on the chain may be unknown to each other. However, the system is reliable and

transparent to the extent that it enables trust between actors. Lindman explains that this means that the blockchain technology does not need a reliable third party to ensure and validate the transactions and Book stress that this is what distinguishes it from other technology solutions. The four experts describe that the inter-organizational trust is altered towards trust in the system of nodes which is enabling governance through technology, acting as an agent, thus replacing institutions. Prophet and Lindman describe that companies may design functions such as smart contracts and payment solutions for the supply chain on the blockchain, which automatically executes transactions based on algorithms. Book further explains that this means that if A and B happens, action C is executed autonomously.

Book advocates the permissioned blockchain technology for companies, as eg. MNCs might find value in knowing the participants on the blockchain as the anonymous characteristics of a permissionless is opposed to the basic logic of companies. In contrast, Magnusson and Prophet, favor the permissionless blockchain technology and describe it to be the most essential as it allows the technology to realize its full potential. This is due to the generative ability and integrative abilities which increases value. Meaning that new projects are created and emerge on the system. Prophet adds that there is no onboarding process, thus no threshold to participate in the chain as long as the set rules are followed, which Magnuson explains make it a cheap alternative to other digitization tools.

"Permissionless blockchain technology is killing organizations in the sense that it fundamentally transforms the way of operating and doing business"

- Magnusson

Blockchain enablers for MNCs

In order for companies to build internal capabilities within the blockchain field, Lindman and Magnusson stress the importance for companies to experiment and conduct pilot projects to achieve organizational learning and this may be done using a third party with blockchain expertise. Magnusson argues that experimenting in a safe environment would reduce the perception of risk connected to blockchain and to realize the benefits it may enhance. In contrast, Book argues that companies need to see a business value in order to start experimenting with blockchain technology.

All four blockchain experts explain that blockchain technology mitigating risks in the supply chains, which enable monetary savings. In detail, Magnusson claim that blockchain technology lowers the cost of compliance, which Lindman and Book explain decreases costs for control. Subsequently, companies gain control and reduce risk. Prophet stresses that when there is high customer demand for reliable information and high stakes in terms of reputability, companies' motivation to implement blockchain increases. Book and Lindman further suggest that companies with high-quality goods are most likely to be motivated to use blockchain in the supply chain to gain evidence of quality. At the same time, Magnusson argues that when it comes to being part of permissionless decentralized platforms, it might increase the perceived risk for a company.

Three of the experts (Lindman, Prophet and Magnusson) state that there is an increasing number of blockchain use case examples within the field of supply chain management. However, Prophet says that the transformation to use a blockchain system may be a result of a marginal phenomenon, such as a supply chain breakdown. Thus, it is particularly useful when the supply chain is located where there is low institutional trust. Further, Magnuson explains that when there is low institutional trust, provenance is a low hanging fruit for companies to use blockchain for. Moreover, all four blockchain experts emphasize that the main business values are increased traceability and the ability to establish the provenance of the material. In addition to tracking and logging components and metals, it increases transparency according to Book. However, Prophet states that traceability of minerals is a short-term gain due to the limited use of tracking, while the long-term gain is autonomous traceability and other supply chain management improvements of social sustainability aspects strengthened by blockchain. This is in accordance with Book who states that the use of blockchain in supply chains may lead to positive sustainability aspects. For example, reversed traceability allows a company to instantly trace the supply chain, thus, to avoid production in an undesirable area or region. Consequently, a company is able to predict potential bottlenecks in the production dependent on the external environment. In addition, Book explains that by using sensors on the blockchain measuring the different levels of materials in components allows for the tamper-proof publication of information.

"If a supply chain is completely expanded with blockchain tracking all components, then you do not have to be surprised by that a certain product is produced in China, as you can easily look it up."

- Book

Magnusson and Prophet express that a company's internal processes, such as governance to ensure compliance and control, increases in efficiency with blockchain. Prophet explains that a supply chain that is managed on a blockchain would be self-audited by the participants. In general, MNCs use permissioned blockchains in supply chains due to the possibility to have a controlled onboarding process to the blockchain system, according to Lindman and the desire to have knowledge of the participants on the blockchain, as expressed by Book.

Blockchain experts': Summary of motivation to use blockchain technology				
Results	Lindman	Prophet	Book	Magnusson
Blockchain-enable functions				
Infrastructure enabling customized design choices	✓	✓	✓	✓
Replaces institutions	✓	✓	✓	✓
Enables decentralized organizations*	✓	✓	✕	✓
Generative technological opportunities*	✕	✓	✕	✓
✓ = *Agrees,* ✕ = *No comment, SC = Supply Chain, BC = Blockchain, *Permissionless BC*				

Table 4.9: Summary of blockchain experts' view of motivation to use blockchain.
Complied by authors based on empirical findings.

4.2.2 Challenges to use Blockchain Technology

Technological shortcomings

As a point of departure, Lindman, Magnusson, and Prophet state that if there is trust in suppliers and the institutions, there is no real need for blockchain technology. Magnusson expresses that

blockchain technology is a fundamentally bad technology if there is trust in the underlying institution. Both Prophet and Lindman express that if there is a well-functioning already established supply chain system, there are few incentives to change for blockchain technology. Moreover, blockchain technology is currently perceived as immature, both from a technical and capability point of view according to Book, Prophet, and Lindman. Book explains that this may be due to questions regarding the stability and capacity to support the loading of data. Lindman and Magnusson say the technology has been experiencing an overblown public discussion criticizing that it might not live up to expectations. Book explains that the technology's functions might not be different from another technology unless incorporated in the company in a holistic manner. Prophet argues that permissioned blockchains are a blind alley and that companies are starting to realize that it is the large open chains that are the most valuable. Further, Magnusson makes a distinction between permissioned and permissionless blockchain technology and explain that the permissioned blockchain technology is nothing new, and not decentralizing control, but rather the maintenance of control by a central node. Meaning that the main function of blockchain is not fulfilled by the permissioned blockchain, where Magnusson express further:

"From my perspective, I only talk about permissionless, I don't see permissioned as a blockchain, it's just a bad suggestion to greenwash a boring technology, to make it sound sexy."

- Magnusson

With regard to technological constraints, Book and Lindman say that there is an ongoing discussion on how to solve the interoperability of different permissioned blockchain systems, as each company designs its blockchain technology dependent on its need, which makes integration of systems technically difficult. Another prominent concern mentioned by three experts (Lindman, Prophet and Book) is the potential to manipulate data inserted in the chain. Thus, when moving from the analogous world to the digital world there might be room for human influence, such as intentional or unintentional faulty data input which leads to contaminated data in the system. Lindman describes that this is a constraint particularly for traceability and provenance cases.

Blockchain adoption obstacles for MNC's

According to Magnusson, many companies' cultures and norms are not suitable for experimenting with blockchain technology, which argues leads to a lack of knowledge regarding blockchain's different capabilities and characteristics. Magnusson explains that particularly for implementing a permissionless blockchain, companies need to let go of the established business idea as blockchain alters the habitual way of doing business. Lindman says that radical innovation is needed, meaning that it is a large difference for companies to move from a centralized system to a more decentralized system. Therefore, Magnusson, Lindman and Prophet explain that companies are creating closed permissioned chains to preserve control, or as a result of lacking knowledge, despite a permissionless blockchain would be the best suitable option with new functions. Prophet emphasizes that companies do not want to participate in another companies' platform as the owner of the platform will be too powerful. At the same time, Magnusson stresses that a profit-seeking actor in control of the blockchain diminishes the chances to get other participants, such as suppliers on the chains.

Prophet state that large MNCs' attitude towards an open, global system is prohibiting capturing value of blockchain. In contrast, Prophet argues that companies need to stop implementing blockchain for themselves and accept an open system.

"There is an analogy with the launch of the internet in the '90s. Companies thought it was very exciting and started to build intranets, but the value was not that they connected computers together to create a closed intranet, the value was that the internet was global with a system for the whole world. I believe that it will be the same with blockchain."

- Prophet

Companies tend to perceive that there are risks involved with the blockchain technology that they might not be willing to take, such as the release of data to second and third parties, according to Magnuson. Prophet expresses that MNC organizational culture aspects, that organizations perceive information to be secret, is hampering blockchain adoption. This, in conjunction with the belief that information has to be shared in a public permissionless chain, contributes to the misperception that blockchain will reveal confidential information. Therefore, in order to implement blockchain, companies need external support to drive the change and increase knowledge of blockchain technology, according to Magnusson. In addition, Prophet claims that due to the MNCs' established company logic, it might be difficult to attract the necessary blockchain knowledge required to gain a deep understanding of the subject. However, it is argued by Book that MNCs need to take the lead to create a change, while Prophet argues that MNCs will not take the lead, it will rather be smaller actors in the forefront of this development.

All four blockchain experts are coherent regarding that MNCs are facing two large implementation challenges in terms of the long pre-implementation phase and in the fact that they are currently lacking a holistic view on the blockchain, which would enable value. Lindman states that there are no large benefits if a company uses blockchain as a transparent logging system for provenance and traceability only, although stating that blockchain might be part of the traceability solution. Similarly, Magnuson stress that the blockchain technology may remain as a margin phenomenon if it is used for provenance and internal information flow purposes. This is in accordance with Book saying that traceability is an indirect side effect and companies may miss the actual value of blockchain. Book explains that those companies need a holistic perspective of blockchain and the value it may add. Therefore, Book highlights that blockchain is not a piece to add to the puzzle, it requires a lot of work and organizational changes. Lindman states that if there are complex supply chains that are lacking infrastructure, thus having no prior digitized system, it might be difficult to implement blockchain in the supply chain. Regarding internal organizational changes, Book explains that several divisions of the company, such as the marketing department and the strategy team need to be involved to collaborate on blockchain development in order to gain the full value of the technology.

Blockchain experts: Summary of challenges to use blockchain in supply chains				
Results	Lindman	Prophet	Book	Magnusson
Technical shortcomings				
No use if trust in suppliers	✓	✓	✗	✓
Immature technology	✓	✓	✓	✗
Permissioned BC not adding functions	✗	✓	✓	✓
Permissioned interoperability problems	✓	✗	✓	✗
Initial supplier can input faulty data	✓	✓	✓	✗
Blockchain adoption obstacles for MNCs				
Traditional business logic	✓	✓	✗	✓
Unsuitable attitude to open systems	✓	✓	✗	✓
Require business value before experimenting	✗	✗	✓	✗
Reluctant to release data	✗	✓	✗	✓
Long pre-implementation phase	✓	✓	✓	✓
Lacking holistic view of implementation	✓	✓	✓	✓
✓ *= Agrees,* ✗ *= No comment, BC = Blockchain*				

Table 4.10: Summary of blockchain experts' view of challenges using blockchain. Complied by authors based on empirical findings.

4.2.3 Governance Changes with Blockchain

Contractual governance

When having blockchain implemented, the entire supply chain is gathered on the same blockchain platform, which all four experts describe as one of the benefits with a permissioned blockchain. Lindman argues that suppliers need to trust in the supply chain system and the easier the use case, the easier the collaboration should be. Meaning that the process is smoother when there is perceived value for all parties. Book stresses that the blockchain technology can ensure specific traits in the suppliers and the component, positively influence the MNCs supply chain management. All four experts highlight that these inter-organizational collaborations need time and resources to be figured out and extensive negotiations to agree on the design and governance system for a permissioned blockchain. Moreover, Prophet says there needs to be reliable data input as sub-suppliers may have incentives to provide faulty data. Therefore, Magnusson, Prophet, and Lindman state that companies still need third-party verification and correspondence to audit the initial stage of the supply chain, regardless of having blockchain implemented.

Non-contractual governance

Magnuson argues that companies need to not only cope with transparency, openness, and collaboration in the supply chain network but also have long-term thinking regarding consequences, such as altered power balances, relationships, and structure. However, it is not clear exactly how the implementation of blockchain alters the characteristics of the network. At the same time, Lindman believes it will increase trust and relationships in the global supply chain.

Blockchain experts: Summary of governance changes with blockchain				
Results	Lindman	Prophet	Book	Magnusson
Contractual governance				
Gather supply chain on common system	✓	✓	✓	✓
Customized design for participants	✓	✓	✕	✓
Third party still needed for initial trust	✓	✓	✕	✓
Non-contractual governance				
Unclear supply chain network dynamics	✕	✕	✕	✓
✓ = *Agrees,* ✕ = *No comment*				

Table 4.11: Summary of blockchain experts' view of governance changes when using blockchain. Complied by authors based on empirical findings.

4.2.4 Blockchain Implementation Facilitators

Bargaining power

In order to implement blockchain, Magnusson explains that companies need to be able to influence the entire supply chain. This is due to the fact that the entire supply chain needs to participate in the chain. Book claims that MNCs need to exert coercive power for implementation, in order to succeed with implementation. In addition, Magnuson stress that the potential shift in power and bargaining power in supply chains is still unknown and it is yet to be discovered how these will affect the companies more specifically. At the same time, all four blockchain experts agree that the MNC remains in control and has large power when having blockchain implemented in the supply chain.

Industry collaboration

The entire industry needs to agree upon standards in order to implement a blockchain platform, according to Lindman and Prophet. This standardization requires a large number of participants to reach an agreement in order for the platform to be of value, which Lindman states may be problematic for traditional organizations. This is in accordance with Book and Magnuson who further stress the importance of common ground within the industry and active participation in the standardization process. If not, Book explains that it will not lead to any momentum and scalability globally. In contrast, Book expresses a constraint in the fact that large MNCs might take the lead in this standardization process, which might favor the large actors. Subsequently it will affect smaller actors in a negative way and therefore it is important to value collaboration and produce standards that are in favor for everyone.

"It is a step to move from proof of concept to sharp operation, especially when you do it on a global scale with many actors because then you need to consider the standardization aspect."

-Book

Prophet emphasizes that some companies are realizing that open permissionless chains are useful as it increases collaboration on an industry-wide level. At the same time, Magnusson claims that a permissioned blockchain implemented with other companies may be useful for an MNC as it gains industry collaboration and spread ownership. As described by Book and Magnusson, an industry-based blockchain can increase transparency for an MNC, as it is a verification transparency model. Similar to supply chain collaboration, Prophet and Magnusson

express that an industry-wide collaboration is easier if the blockchain technology enables low hanging fruits for participant companies. Magnusson expresses that provenance could be an example of a low hanging fruit.

Blockchain experts: Summary of blockchain implementation facilitators				
Results	Lindman	Prophet	Book	Magnusson
Bargaining power				
Ability to influence supply chain required	✓	✗	✓	✓
Coercive power required implementation	✗	✗	✓	✗
MNC maintain in control with common supply chain system	✓	✓	✓	✓
Industry collaboration				
Standardization needed in the industry	✓	✓	✓	✓
Increases supply chain transparency	✗	✗	✓	✓
Industry wide goal needed for collaboration	✗	✓	✗	✓
✓ = *Agrees,* ✗ = *No comment*				

Table 4.12: Summary of blockchain experts' view of implementation facilitators. Complied by authors based on empirical findings.

5 Analysis

The following chapter will analyze and compare the empirical findings from the automotive MNCs', the blockchain experts in relation to the literature chapter. Firstly, the chapter presents the analysis model. Secondly, the chapter discusses each parameter from the analysis model, consist of motivation, challenges, contractual - and non-contractual governing, with two additional governance factors labeled blockchain facilitators, including bargaining power and industry collaboration, which influences the blockchain implementation.

5.1 Analysis Model

The analysis follows the structure based on the conceptual framework, presented in section *2.5 The Conceptual Framework*, developed into an analysis model, described in section *3.5 Data Analysis.* The analysis is based on the case findings in conjunction with the theory, which determines the gaps towards using blockchain. The gaps are inherent in the MNCs' driving forces, meaning the motivation and challenges, in the MNCs' global supply chain governance structures, meaning the contractual and non-contractual governance, and in the blockchain implementation facilitators. Thus, what the implementation barriers are in moving from the current state to operate with blockchain implemented. In answering the research question, the generated propositions are grouped into these five themes.

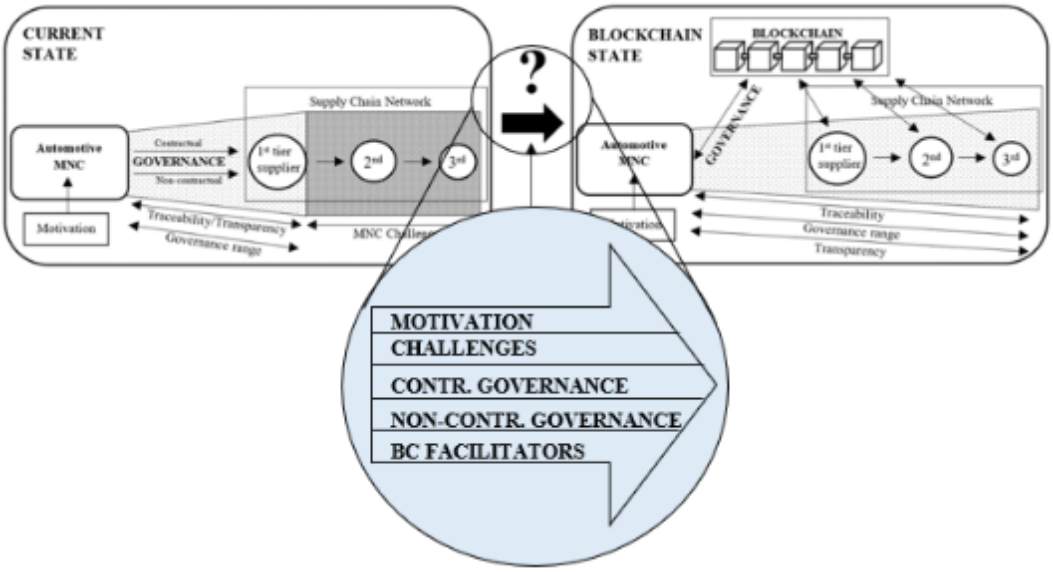

Figure 5.1: The analysis model. Compiled by authors.

5.2 MNCs Driving Forces in Global Supply Chains

This section delineates the first part of the analysis, containing the characteristics of the automotive MNCs with the purpose of comparing the current motivation and challenges in global supply chains, to the motivation and challenges with blockchain adoption changes. Moreover, what potential barriers the area consist of. This is discussed along with the findings from the blockchain experts.

5.2.1 Motivation for Sustainability and Transparency

The first parameter discussed is MNCs' motivation. Based on the findings, it is determined what the adoption barriers are in relation to motivation. These are analyzed in two subsections, divided into the MNC perspective which is followed by a discussion of additional aspects lifted by the blockchain experts.

5.2.1.1 MNCs' Motivational Barriers to Blockchain

Stakeholder and institutional pressure

All six companies state that their main motivation to engage in sustainability is related to transparency concerns, where four companies (Company X, Volvo Cars, Volvo Bus, Volvo Group) do this in a general aspect and three companies (Volvo Cars, Scania, Volvo Trucks) strive to reach transparency for specific raw materials. The majority of the MNCs (Company X, Volvo Cars, Volvo Buses, Volvo Group, Scania) state that to engage in sustainability is due to stakeholder pressure. This is aligned with theory, both regarding that socio-ecological benefits to stakeholders is a key motivator (Silvestre et al., 2018) and that transparency is necessary to improve sustainability upstream the supply chains (Mani et al., 2015; Chen, 2018), which is seemingly grounded and enhanced by stakeholder pressure.

Considering that there is a consensus among the MNCs, the findings indicate that there are institutional pressure and norms within the automotive industry to become more transparent and subsequently more sustainable, and that this is necessary to be legitimate (DiMaggio and Powell, 1983). This argument is strengthened by the fact that four companies (Company X, Volvo Cars, Volvo Group, and Volvo Trucks) reveal that over compliance with laws is necessary. Thus, this is decreasing the importance of legal, coercive pressure and increasing the importance of normative and mimetic industrial pressure. At the same time, no company mention legislation or regulatory compliance as a motivation to implement blockchain, in contrast to the theory (Venkatesh et al., 2020), which indicates that blockchain is not seen primarily as a tool used to comply with laws.

The MNCs' motivation for sustainability is in accordance with data regarding the MNCs' motivation to implement blockchain, as both based upon transparency. The MNCs motivation to use blockchain to increase transparency is aligned with both the perspective gained from theory (Bai and Sarkis, 2020; Baralla et al., 2018; Roeck et al., 2019) and all four blockchain experts, indicating that the need for transparency is a main motivational factor to implement blockchain. However, despite the coherency in sustainability being the motivation for transparency and that transparency is motivation to use blockchain, there is a striking difference regarding the underlying factors between the motivation to engage in sustainability and the motivation to use blockchain, as there are different underlying reasons as to why transparency is a motivation.

More specifically, two companies in the study are aligned with theory (Baralla et al., 2018; Roeck et al., 2019), as both Volvo Cars and Scania mention stakeholder pressure as a motivation to implement blockchain technology in their supply chains. These are also the

companies mentioning that they want to enhance social sustainability upstream the supply chain and believe that blockchain can be a solution, which corresponds with Hughes et al, (2019), Venkatesh et al., (2020), Weygand et al., (2019), and two of the blockchain experts (Prophet and Book), thus that blockchain technology is implemented for traceability when operating in economic and socially unstable countries. Thereby, it may be argued that there is a correlation between the factors, stakeholder pressure, and social sustainability, leading to motivation for blockchain implementation for the MNCs'. This correlation is strengthened by the fact that blockchain expert Prophet explains that companies' motivation to implement blockchain increases when there are high stakes involved, such as brand reputation and customer demand for reliable information.

In fact, Volvo Cars, the only company that has implemented blockchain is also the only company mentioning both customer demand and brand reputation as motivations to engage in sustainability, while emphasizing that their blockchain motivation is due to stakeholder demand for sustainability. This finding is contradicting Kim and Davis (2016) study which showed that motivation to engage in corporate social responsibility or ability to trace is not dependent on either reputation or public visibility. Therefore, this is indicating that brand and reputation might, in fact, influence the motivation to increase transparency, subsequently leading to blockchain implementation. On the other hand, it may be questioned to what extent companies are adopting blockchain to increase transparency for a sustainability purpose, as the majority of the MNCs', do not see social sustainability and stakeholder pressure as their main motivation to implement blockchain. Based on the argument that MNCs' motivation for sustainability is influenced by institutional and external stakeholder pressure, this could logically influence the implementation of blockchain for MNCs in the study. Consequently, it may be argued that there is a lack of institutional and external stakeholder pressure within the automotive industry, which is a prerequisite to increase transparency by using blockchain to enhance legitimacy, thus a barrier to implement blockchain.

Selective transparency

While all companies in the study explains that transparency is essential in the global supply chain to retrieve knowledge, in accordance with Goldstein and Newell (2020), the findings indicate that some companies (Volvo Cars and Scania) believe that transparency in all supply chain is out of their reach, and not necessary at all times, as traceability might be sufficient. Thus, this suggests that although transparency is pivotal, it is not aimed for. The fact that the MNCs are aiming for transparency in certain prioritized and targeted supply chains, this indicates a pattern of selective transparency. At the same time, this might be due to the complexity in automotive supply chains (Kim and Davis, 2016), making it unrealistic to aim for greater transparency.

Another perspective with regards to selective transparency is that although a company has multi-tier information, the company may choose what to disclose (Boström et al., 2015; Sodhi and Tang, 2019). Thereby, it may be argued that despite Volvo Cars full transparency in one supply chain enabled by blockchain, this is not per se automatically communicated to stakeholders, thus it is dependent on the company's strategy (Barney, 1991). This is further

strengthened by the data showing that MNCs prefer to use permissioned blockchains, indicating that the data gained in the supply chain is viewed as a resource. On the other hand, based on Roeck et al. (2019) and Baralla et al., (2018) the effects that transparency may have on brand and legitimacy, it is seemingly pivotal to be transparent to retrieve the benefits of implementing blockchain technology in the global supply chain. However, as companies aim to use blockchain-based information flows in a few supply chains, they may select the level of external transparency dependent on the configuration of technology and company strategy, this indicates that the increased level of transparency could be fairly limited.

Internal efficiency focus
The majority of the MNCs' (Volvo Cars, Scania, Company X and Volvo Trucks) are motivated to implement blockchain to increase efficiency in audits. Whereas, Volvo Cars and Volvo Trucks are also the two companies emphasizing that the amount of time spent on governance is too extensive. This is correlated to the motivation factor that the blockchain experts (Magnusson and Prophet) and the literature (Feng et al., 2018; Angelis and Da Silva, 2019; Hughes et al., 2019) mention, thus blockchain enables more efficient governance of the global supply chain. In addition, the data retrieved from the blockchain experts (Magnusson and Prophet) show that blockchain is particularly useful when there is a low degree of institutional trust and that the blockchain would reduce the need for the third party to govern the global supply chain. Nevertheless, considering the spread of the cases' motivational aspects, blockchain implementation is likely to not be driven by sustainability aspects, nor transparency, but instead, other company-specific internal efficiency processes, related to traceability, such as material flow and auditing. Therefore, blockchain-enabled transparency to enhance sustainability might be an indirect effect stemming from more efficient audits and increased information to influence lower-tier suppliers, rather than the main outspoken factor to implement blockchain within the automotive industry. At the same time, data from both MNCs (Volvo Trucks and Scania), along with blockchain experts (Magnusson, Lindman and Book) show that there are other technologies that could increase internal efficiency. Therefore, blockchain might not be the solution if internal efficiency is the sole purpose. Based on the findings, the following propositions are made:

P1a: Blockchain adoption for sustainability purposes is influenced by institutional and stakeholder pressure.
P1b: Blockchain implementation is dependent on the need for transparency.
P1c: The smaller the MNCs perceive the company-specific benefits, the larger the barrier to implement blockchain.

5.2.1.2 Blockchain Experts View on Additional Motivational Barriers
All four blockchain experts express that the automotive MNCs' motivation to implement blockchain should be to minimize supply chain risks, which aligned with literature (Korpela et al., 2017; Kshetri, 2018) indicate that blockchain is a safe and secure system that may, in fact, lead to decreased supply chain risks. Bai and Sarkis (2020) mention that blockchain implementation in the supply chain could have a positive influence on firm performance and two experts (Lindman and Book) state that blockchain could lead to monetary savings when

implemented. However, only one company (Scania) mention risk-minimizing as a driver to implement blockchain, and none of the respondents in the automotive MNCs mention increased firm performance as motivation to use blockchain. In addition, two of the blockchain experts (Lindman and Magnusson) describe that the MNCs need to experiment and try out the technology in order to find the value for their specific organization, aligned with theory (Hughes et al., 2019; Roeck et al., 2019). This is aligned with the findings, as three companies (Company X, Volvo Group and Scania) have initiated pilot projects in their supply chains and one company (Volvo Cars) has implemented blockchain in one supply chain. Thus, this is indicating that the MNCs are still early in the learning process and therefore might have limited knowledge of what their motivation to implement blockchain is, as data shows that MNCs' have a variety of reasons for implementing blockchain.

In regard to knowledge and motivation, the blockchain experts' data contains a lot of technical enablers that blockchain technology will enhance, meaning that these technical enablers should be motivational factors to implement the technology. However, none of the MNCs' are mentioning any of these, more than efficient audits. This might be explained by the fact that many of the technical enablers that the blockchain experts mention is related to the permissionless blockchain e.g. no ownership, open for anyone, fully traceable and high scalability, in line with Bauman et al. (2016) and Rejeb et al. (2019). However, as explained by the experts (Magnusson and Prophet), the MNCs' motivation to implement blockchain is not to lose control, rather increase control. This argument is strengthened by the findings from the MNCs (Company X, Volvo Cars and Scania), as their motivation to use blockchain is to gain control and traceability in the global supply chains. Therefore, it may be argued that the MNCs have limited interest in the permissionless blockchain, thereby lacking knowledge regarding the different configurations, which lead to a lack of knowledge of what the blockchain technology, in fact, could generate. Although there are some differing opinions, the blockchain experts have an enlarged view on what the motivation to implement blockchain is. Based on the findings, the following proposition is developed:

P2: The less experience and knowledge MNCs' have of blockchain technology, the larger the barrier to implement blockchain.

5.2.2 Global Supply Chain Challenges

The second parameter discussed in MNCs' driving forces is challenges. Based on the findings, it is determined if their challenges can be met by blockchain and what the adoption barriers are. These are analyzed in two subsections, divided into the MNC perspective and additional aspects by the blockchain experts.

5.2.2.1 MNCs' Perceived Challenges of Blockchain

Inter-organizational information sharing

The MNCs' current global supply chain challenges are closely related to the MNCs' perceived challenges to implementing blockchain. The automotive MNCs in the study and theory (Sodhi and Tang, 2019) state that there is a lack of information flow within MNCs' global supply chains, which is underpinning many of the challenges. In addition, five companies (Company

X, Volvo Bus, Volvo Group, Scania and Volvo Trucks) mention that complex supply chains are prohibiting transparency and governance, making it difficult to achieve any information flow or transparency beyond first-tier suppliers, as described by Fayezi et al., (2012). This is also aligned with Kim and Davis (2016), meaning that an increased level of complexity, such as in the automotive supply chains, decreases the level of transparency, thus the information flow in the supply chain. This problem is intensified, as all MNCs express that there is a reluctance to share information in the industry, where Scania describes that some suppliers consider information to be their competitive edge. Subsequently, based on the arguments by Thomsen and Pedersen (2000), goal misalignment in the supply chain is hampering the collaboration needed for information sharing.

In the context of blockchain technology, three companies (Volvo Buses, Volvo Group, Scania) mention an unwillingness to share information with suppliers. This is visible in Volvo Cars who has an interface on their blockchain technology allowing them information, although restricting information flowing upstream the supply chain. This is in accordance with theory (Rejeb et al., 2019) and blockchain experts (Magnusson and Lindman) that permissioned blockchain gives a monopolistic approach to the controlling actor, suitable when having a reserved attitude to data sharing. Moreover, Montecchi et al (2019), state that blockchain increases exposure to other actors and increases the risk for leakage of supply chain details and sensitive information. However, this is contradicting the blockchain experts as the release of data is argued to be a misperception. Firstly, all information in the blockchain may be encrypted and as Magnusson and theory (Azzi et al., 2019; Biswas and Gupta, 2019; Wong et al., 2020) expresses it, you only share what you want to share on the blockchain. Secondly, if it is a permissioned blockchain, the company makes the design to suit the purpose and is therefore in control of the information flow (Baralla et al., 2018; Biswas and Gupta, 2019). Therefore, the reservation from the MNCs' to release data is hampering blockchain implementation.

Lower-tier information asymmetry

The findings reveal that some of the companies (Volvo Buses, Volvo Trucks and Volvo Cars) have to rely on trust towards suppliers, as there is a lack of resources to verify information, engage in relationship building and information sharing, thus to bridge information asymmetry (Boström et al., 2015; Vosooghidizaji et al., 2019). According to the data from all MNCs', one major challenge in the global supply chains is social sustainability, which Company X express, aligned with Venkatesh et al (2020), particularly occur in the lower-tier suppliers where geopolitical differences are the largest. As expressed by Volvo Cars, lower-tier suppliers specifically may have incentives to not cooperate and instead provide faulty information. Based on Liu's (2018) findings, this may be explained by the fact that divergent interest and poor supply chain relationships, or no supply chain relationships, as the MNCs' findings indicate an increased likelihood of opportunistic behavior, thus resulting in social sustainability concerns. Thereby, it may be argued that there is a degree of interconnectedness between complex supply chains, reluctance to share information which is resulting in social sustainability challenges. Based on these arguments, this indicates that Eisenhardt's (1989a) and Jensen and Meckling (1976) discussion of the agency problem is arguably confirmed in the automotive industry. In

other words, the agency problem, thus, opportunistic behavior, may be interpreted as a challenge for the automotive MNCs.

Prior studies on the agency dilemma indicate the importance of information sharing as fundamental to reduce the agency problem (Eisenhardt, 1989a). Both findings and literature (Sodhi and Tang, 2019) indicate that traceability is a rising concern, forcing companies to increase the information flow further. The data indicates that the MNCs have implemented different governance tools and mitigation activities to increase the information flows, which is aligned with previous studies (Eisenhardt, 1989a; Fayez et al., 2012). However, companies today, exemplified by the case of Volvo Cars, are implementing permissioned blockchain technology in few selected supply chains, where control remains fairly centralized (Biswas and Gupta, 2019; Norberg, 2019), thus withholding the principal and agent relationship, although with partly increased information flow from lower-tier suppliers to the MNC. Therefore, considering the MNCs' unwillingness to release and share data within the supply chain, it may be argued that the agency dilemma would not be reduced to a greater extent by the blockchain technology. To conclude, there is an understood skepticism to adopt blockchain, visible in the majority of the cases (Volvo Buses, Volvo Group, Scania, Volvo Trucks), indicating a doubt if blockchain technology is being the solution to their current problems, thus questioning whether it is, in fact, optimal to maximize value in their respective MNC. Based on the findings, the following proposition is developed:

P3: The higher the resistance to information sharing the higher the blockchain implementation barrier.

5.2.2.2 Blockchain Experts View on Additional Challenges

Unknown business value

Important to note is that the data sample indicates that there might be a discrepancy between the blockchain experts and the MNCs' perception of business value. The blockchain experts (Lindman and Magnusson) agree with the MNCs regarding that it might be difficult to find obvious business values if blockchain is used as a traceability system. As described by Book, altering one already functioning supply chain system to a blockchain system might in fact not add any functions to the MNC. At the same time, the expert's (Book and Lindman) are aligned with the literature (Bai and Sarkis, 2020) that blockchains most essential contribution, in comparison to other technologies, is the transparency and security of the system. Thereby, it may be argued that there is some additional value also with the permissioned blockchain, although not being significant and therefore MNCs have difficulties in capturing the value of blockchain.

Furthermore, the findings from the blockchain experts (Lindman, Prophet and Magnusson) and theory (Bateman, 2015; Bauman et al., 2016) show that the permissionless blockchain means that no ownership or direct control may be executed. Based on the findings, this is not in line with the MNCs' view on control and demand for ownership for strategic advantage (Barney, 1991). This fact is strengthened by Volvo Cars, stating that they use blockchain to increase supply chain control and that they have been choosing their own suppliers. Book and Lindman

express that this is the preferable blockchain for most MNCs' as they can maintain control over the onboarding process (Book and Lindman), which are the main characteristics of a permissioned blockchain (Biswas and Gupta, 2019). On the other hand, regardless of the type of blockchain, the data from the blockchain expert Book show that blockchain should be incorporated with a company holistic mindset, thus aligned with Bateman (2015) meaning that it is crucial to avoid data management conducted in silos. Consequently, the MNCs are lacking a holistic view of both the blockchain technology and its implementation, which may be argued to limit the perceived value.

Technical aspects of blockchain

Regarding blockchain as a solution, there are some technical constraints that have not been mentioned previously in the literature review. Both Lindman and Book explain that there are interoperability challenges between different blockchain systems, meaning that is is not possible to connect different blockchains at this stage. Consequently, this may increase the perceived barriers to use blockchain as all companies in the automotive industry could end up with different blockchains, and suppliers would need to be connected to several blockchains, as Company X explains that several MNCs often use the same suppliers. Therefore, blockchain can get complicated as actors and the industry need to agree upon the implementation process, aligned with (Bai and Sarkis, 2020), however, it is a challenge. Thereby, it may be interpreted that as long as there is no interoperability between the different blockchains used by different companies, this could hamper industry-wide collaboration and decreasing supplier incentives to join one blockchain network, due to the inefficiency to use several different blockchains. Thus, this would reduce the suppliers' incentives and the MNCs' possibilities to implement blockchain in their global supply chain networks. Based on the findings, the following proposition is developed:

P4: The perceived value of blockchain is dependent on having a holistic view and interoperability between the blockchain systems.

5.2.3 MNC's Current Challenges and MNC's Blockchain Motivation

In order to be able to draw conclusions regarding the implementation barriers inherent in the automotive MNCs, the findings from the two parameters, motivation, and challenges, have to be analyzed together. This, as it is by logic presumed that the adoption of blockchain is dependent on the enabled benefits in relation to the automotive MNCs' challenges.

While the blockchain experts (Lindman, Magnusson and Prophet) state that if there is trust in suppliers and institutions there is no need for blockchain, the data from the MNCs indicates that one major challenge is the complexity in the global supply chains resulting in the fact that all six cases have transparency solely to the first tier-level. Aligned with blockchain expert Magnusson, both Volvo Trucks, and Volvo Buses state that they have trust in their suppliers as there is no other option due to the lack of resources to establish more transparent systems. Considering that the six cases describe social sustainability and reluctance to share information on a supply chain-level being major challenges today, this suggests that there is a need for

greater information sharing and governance to ensure sustainability compliance in the MNCs' global supply chains. Thereby, this is indicating that the level of trust in many supply chains is fairly low. However, in the MNCs' motivations to use blockchain, nor trust or social sustainability is highlighted as a direct motivation. This is contradicting both the blockchain experts and literature (Bai and Sarkis, 2020; Saberi et al., 2019), meaning that there would be a need for blockchain in the MNCs' global supply chains, as the less trust there is, the more need for blockchain there should be. In addition, two blockchain experts (Prophet and Book) argue that blockchain may, in fact, ensure social sustainability in lower-tier suppliers. Therefore, this indicates that trust and social sustainability alone might not be reasons strong enough to invest in blockchain technology to increase transparency.

When considering the coherence among the MNCs' perception of what blockchain could do for their challenges, but the discrepancies towards the blockchain experts' arguments for what blockchain can do, this indicates that the MNCs do not perceive that blockchain can meet their expressed challenges to any greater extent. This is contradicting the blockchain experts who are in accordance with the literature (Azzi et al., 2019; Kshetri, 2018) saying that blockchain technology may serve multiple purposes, increase social sustainability, lower-tier governance, safe information sharing and traceability in the supply chain, leading to transparency. Based on these arguments, blockchain could thereby decrease complexity in supply chains and in fact provide solutions to several MNCs' challenges. However, the different views might be a result of the blockchain experts not having full insight in the MNCs' operations and reality as they have a more technical, innovative mindset, not seeing the MNCs more traditional realm. Nevertheless, this indicates that there is a knowledge gap in what blockchain may do for the MNCs' challenges, aligned with (Venkatesh et al., 2020; Wong et al., 2020), and this is a barrier to use blockchain for these purposes. This argument is strengthened by the data retrieved from the blockchain experts, showing that MNCs need to find a low hanging fruit in order to find motivation strong enough to find the blockchain technology relevant. Based on the findings, the following proposition is proposed:

P5: MNCs' perception that blockchain is not suitable for the current global supply chain challenges, increases the implementation barrier.

5.3 MNCs Global Supply Chain Governance

This section delineates the second part of the analysis, containing the characteristics of the automotive MNCs with the purpose to determine if the current governance in global supply chains compared to the governance with blockchain adoption changes and what barriers that might be. This is discussed along with the findings from the blockchain experts, starting with the contractual governance, followed by non-contractual governance.

Firstly, as a point of departure, the data sample indicates that the companies agree upon the literature (Boström 2015), meaning that it is important to have both contractual and non-contractual remedies in place in order to enable more efficient governance. Based on what was identified in the literature (Lu et al., 2014), the choice of governance mode is dependent on the

context and cost of compliance. The data shows that most companies have established governance remedies, all fairly similar across the sample to govern the supply chain. Based on the logic of DiMaggio and Powell (1983) this may be explained by the fact that the sample is engaged within the automotive industry, with a standardized governance system that all companies follow in order to ensure legitimacy. In addition, considering the high level of complexity in the automotive MNCs supply chains, the choice could also be dependent on the ability to retain information, thus limiting the alternatives to the number of resources available for the global supply chain governance.

5.3.1 Contractual Governance

First-tier governance

The theory says that contractual remedies with suppliers are used for the purpose to increase monitoring and control in order to reduce information asymmetry (Boström et al, 2015), increase transparency, and lower transaction costs (Carter and Rogers, 2008). The results from the MNCs show that all six cases mainly have standardized contracts and evaluations with first-tier suppliers, which according to theory (Broström et al., 2015) will reduces information asymmetry. It is aligned with the findings, although limited to the first-tier level. In addition, this suggests, in line with D'Eusanio et al., (2019), that the influence is limited to parts of the supply chain. In contrast to the theory (Koberg and Longoni, 2019; Ivarsson and Alvstam, 2009; Nassar et al., 2019), the automotive MNCs are, in general, not competing with their entire supply chain. The only exception is one global supply chain for Volvo Cars, who describe this transparency being driven by stakeholder demand for larger accountability.

Based on the literature (D'Eusanio et al., 2019; Villena and Gioia, 2018; Zimmer et al., 2017), to rely only on first-tier suppliers hampers the implementation of sustainability practices beyond the first-tier suppliers. This is aligned with Company X who describes that it is well known that the violations of their requirements occur in the lower tiers, aligned with theory (Rindfleish and Heide, 1997). In addition, only first-tier transparency may cause disruptions in global supply chains. Scania, for example, describes that they are lacking knowledge regarding the products' exact origin and have limited knowledge of upstream suppliers. This has affected the company during the Covid-19 outbreak and could have been prohibited with greater visibility and traceability. Volvo Trucks mention, in regard to the Covid-19 outbreak, that their supply chains are fragile for disruptions, and more information is required to conduct proper risk assessments. This is strengthened by Shi et al (2019), who express the need for information transparency on a supply chain level to adjust and enable improvements of resource allocation. However, in order to implement blockchain, based on the same principle used for sustainability (D'Eusanio et al., 2019; Villena and Gioia, 2018; Zimmer et al., 2017) and data from Company X and Volvo Cars, express that beyond first-tier transparency is a significant prerequisite to succeed. The entire supply chain needs to be known and aligned with the purpose of implementing blockchain (Bai and Sarkis, 2020), which is argued by Volvo Cars to be fundamental, and figuring this out is according to Company X an extensive work. Therefore, it may be argued that as long as there are no contractual remedies beyond the first-tier supplier level, transparency will not increase, thus more resilient global supply chains will not be developed.

The reason to why the automotive MNCs are not moving towards more modern direct links with sub-suppliers is explained by Volvo Cars, Volvo Group and Volvo Trucks to be time- and resource constraints, where Volvo Trucks further explain it to be extremely costly. Considering the MNCs current stage, thus moving from having contractual agreements with first-tier suppliers to have multi-tier contractual agreements to implement blockchain is a magnitude change. This argument is strengthened by all four blockchain experts emphasizing the inter-organizational collaboration and resource-consuming process to establish the contractual agreements for implementing blockchain. Meaning that the current contractual governance system, where the MNCs have first-tier contractual agreements and transparency is prohibiting a blockchain implementation. Therefore, based on the findings, this suggests that the automotive MNCs are not competing with their supply chain, which contradict D'Eusanio et al., (2019), they rather compete with a selective sample of first-tier suppliers, and this is suboptimal for implementing blockchain.

Sub-supplier governance

As previously described, the automotive MNCs are exclusively relying on the first-tier supplier to ascertain necessary information further upstream of the supply chain. Similarly, all companies, in contrast to Boström et al. (2015), express that they do not exert responsibility beyond the first-tier supplier either. Further, this is not aligned with the literature saying it is crucial to enhance transparency in the supply chains to be able to influence the management of lower-tier risks and regulatory compliance (Bateman, 2015). At the same time, the findings show that the MNCs are increasing transparency in the supply chains regarding specific raw material and that social sustainability concerns in lower tier are essential. Based on the agency dilemma (Eisenhardt 1989a), it is thereby argued that the MNCs are increasing transparency where the information asymmetry and opportunistic attitudes are perceived to be the highest, and where there are largest compliance gaps (Boström et al., 2015). This is strengthened by Company X, that sub-supplier governance is needed the most where there is low trust and as Magnusson and Prophet explain, where there is a lack of institutions, and confirming that sub-suppliers in the supply chain often have dispersed interest (Shi et al., 2019; Kano 2018). However, Volvo Buses and Volvo Cars data show that the automotive industry is conservative and highly complex in terms of global supply chains, and suppliers in countries with low institutional trust and lacking governance might have incentives to continue with unethical practices such as forced labor in the supply chain. In fact, as described by Scania, suppliers might be unwilling to share information as they perceive it to be a competitive edge. This means that the resistance for blockchain might be the highest where it might be needed the most. Therefore, in order to implement blockchain that increases traceability, which enhance transparency, the incentives to participate in the blockchain than to not participate in the blockchain must be higher.

The findings show that it is hard to govern sub-suppliers as the suppliers are lacking transparency off their actions and therefore hard to trust, which is why multi-tier evaluation is required to reduce opportunistic behavior (D'Eusanio et al., 2019). However, when selecting participants to the blockchain network, this would enable the MNCs to ensure that the suppliers

and sub-suppliers they are working with are sustainable, meaning that there is a natural selective evaluation process. Based on D'Eusanio et al., (2019), it may be argued that a blockchain is a tool for evaluation. This is aligned with Volvo Cars and Magnusson, meaning that if a supplier is participating in the blockchain, it can easily be evaluated if it is aligned with the MNCs' goals and criteria, thus reduce opportunistic behavior in the supply chain by an increased governance range. Subsequently, suppliers with sustainable businesses are also the suppliers willing to participate on a blockchain, automatically leading to a sustainable supply chain. However, based on data from Scania, participating suppliers need to develop a certain level of maturity, skills, and sufficient infrastructure in order to facilitate the implementation, aligned with Korpela et al. (2017). Thereby, it may be argued that where blockchain is able to be implemented, where more modern facilities allow for a modern technology, these might not be the areas needed the most, thus where social sustainability problems occur in existing supply chains.

In addition to the literature, in regard to suppliers' interest in blockchain, Company X state that the bottleneck to use blockchain is not the technology, rather the suppliers' interest to participate in the blockchain network. This might be complicated in a blockchain implementation perspective, as two of the MNCs express that they are dependent on the suppliers, and have fragile supply chains, thus difficulties in changing suppliers for some components. This indicates that the MNC is likely to struggle when onboarding the suppliers. This is not aligned with Kitzmueller and Shimshack (2012), who says that change is more likely to occur when firms are dependent on each other. In this case, it might be interpreted that change, in terms of blockchain implementation, is not likely to occur as long as the MNC is dependent on their suppliers. In fact, according to data from the case of Volvo Cars, blockchain implementation needs to be conducted in new supply chains, meaning that it is difficult to pursue with a blockchain implementation in existing global supply chains due to extensive work. Thereby, it may be argued that the blockchain system is not a technology that is implemented with a play button, it is a lot of networking, conceptualization and testing required prior to implementation and this is preferably done when selecting new suppliers.

Third-party governance

The current system for contractual governance contains multiple channels and sources to ensure a sufficient amount of reliable information. All MNCs' data shows that to ensure supplier compliance, audits are mostly outsourced to a third party actor and are an integral part of the six MNCs' governance systems, thus these findings are in line with theory (Koberg and Longoni, 2019; Korpela et a., 2017; Lu et al., 2014). According to both the empirical findings and literature (Tan et al., 2018), this is used to increase the accuracy and reliability of the information. However, as Magnusson describes it, blockchain enables self-governance of the supply chain, meaning that blockchain is altering the different channels to one tool and extends the governance upstream of the supply chain, aligned with Boström et al., (2015). At the same time, the experts (Prophet, Magnusson and Lindman), aligned with Volvo Cars and Saberi et al. (2019), explain that the need for auditing when using blockchain in the supply chain will not disappear but decrease.

In more detail, both findings from the literature (Hughes et al., 2019), the blockchain experts (Lindman, Book and Prophet) and the MNCs (Company X and Scania) indicate there is, in fact, a problem to ensure that there is no faulty data input at the initial stage of the blockchain, either intentionally or that suppliers have incentives to provide faulty data. Prophet expresses that when there is garbage going into the system, there is garbage going out of the system, meaning that the data is contaminated. Volvo Cars describe that sub-suppliers might alter the provenance of a material due to economic incentives, as the material from one mine might be more valuable than another. At the same time, the findings indicate that Volvo Cars, who has blockchain implementation experience, has found a solution by having high incentives for the suppliers to provide correct data. The solution is the use of a third party in the process that monitors the process, and enhanced accountability by incorporating security technologies such as face recognition. This implies that the arguments by Azzi et al., (2019), that blockchain enables designing of component-specific suitable tracking devices, is a solution for the initial faulty data input, which is currently a perceived barrier for the MNCs to adopt blockchain. Thereby, this indicates that there might be 'learning by doing' factors that provide the MNCs with knowledge on how to solve occurring problems, although it is not possible to exclude the need for a third party at the initial stage in the blockchain where the first data input occurs.

Knowledge of governance transformation

Blockchain is argued to be well suited for supply chains due to its inherent characteristics, which the blockchain expert Magnusson describes to enable gathering the entire supply chain on the same system, with shared ownership and collaboration. The four blockchain experts, in line with the literature (Biswas and Gupta., 2019; Venkatesh et al., 2020), explain that the system is safe, and can be designed based on the companies' needs and requirements, which can be predetermined in the technology and results in different interfaces for each user (node). However, few of the MNCs expressed knowledge regarding the blockchain-enabled changes in regard to contractual governance. Volvo Trucks and Scania expressed the belief that blockchain will facilitate their business by increasing trust to suppliers and decrease the administration processes, which is in accordance with the studies by Kshetri (2018) and Queiroz and Wamba (2019). Therefore, according to the data, the majority of the automotive MNCs are lacking knowledge and experience regarding potential transformations in the supply chain governance with blockchain. Based on Wong et al. (2020) and Roeck et al. (2019), this might have an interconnected dual explanation, both that there are no use cases as a result of companies, in fact, do not have the experience, or that companies are hesitant due to their lack of knowledge stemming from no use cases available to learn from. Based on these findings, the following propositions are formulated:

P6a: First-tier contractual governance and limited transparency are hampering blockchain implementation.

P6b: The lower the supplier incentives and interest, the higher the blockchain implementation barrier.

P6c: Technical constraints when moving from the analog to the digital world maintain the need for third-party governance, which decreases the value of blockchain.

P6d: The less knowledge and use cases available on contractual governance transformation, the larger the barrier to implementing blockchain.

5.3.2 Non-Contractual Governance

Multi-tier systems for relationship building

All companies in the study, in accordance with previous studies (Wiengarten et al., 2010; Grimm et al., 2016; Ahmed and Omar, 2017; D'Eusanio et al., 2019), express that multi-tier information sharing is valuable out of a performance perspective. In contrast, the data on the MNCs' actual supply chain activities are indicating that this is not the reality, as the MNCs collaboration and information sharing are, like the contractual remedies, remaining primarily on the first-tier level. At the same time, the theory describes that supply chain coordination that enables information sharing is resource consuming (Chaudhuri et al., 2019). This is aligned with Volvo Cars and Volvo Group, who describe that resources for governance need to decrease. Subsequently, the MNC priorities are seemingly deciding the level of inter-organizational collaboration and relationship.

According to the findings, there is no integrated information system in the automotive MNCs' current supply chains, except for the formal governance systems containing the first-tier suppliers. The theory (Shi et al., 2019; Sodhi and Tang, 2019) say that companies should invest in systems that will ensure information transparency even though it is costly, meaning that it is a necessity in modern business. Subsequently, it may be argued that the complex supply chains require technology to cope with the MNCs' current supply chain challenges, despite that it is difficult to find a system compatible on an inter-organizational level. This argument is strengthened by Bateman (2015), and the cases in the study (Volvo Buses and Scania) indicating that different standards and technologies between immense numbers of suppliers in a global supply chain make it complicated to create a system for a multi-tier supply chain purpose.

In line with the study by Li et al. (2019), Volvo Cars and Volvo Trucks describe that long-term perspectives with suppliers improve supply chain relationships. When the supply chain participates in a common system this streamlines the interest and integrates the suppliers into the MNC's business, meaning that a larger degree of commitment, thus long-term perspective occurs when having blockchain implemented, as described by Volvo Cars. The theory mentions that supply chain traceability and visibility increases transparency, which can be enhanced by inter-organizational networks creating successful global supply chain governance, leading to trust and joint decision-making (Ahmed and Omar, 2017; Sodhi and Tang, 2019; Vosooghidizaji et al., 2019). This is arguably valid in this study, as the data from the MNCs (Company X, Volvo Cars, Scania, Volvo Buses) mention that relationships may lead to product development. For example, Volvo Buses express their open-book collaboration with suppliers leading to essential product development. Moreover, the literature (Abdullah and Musa, 2014; Tan et al., 2018) explains that relationships are needed to increase collaboration, subsequently leading to enhanced traceability, and this is seemingly valid when having implemented blockchain due to the technology's characteristics. On the other hand, considering that the third party actor is highly involved, both in the implementation and post-implementation process of

blockchain, as explained by Volvo Cars, it might be questioned to what extent the lower-tier relationship building, in fact, is influenced.

Volvo Cars conducted the implementation with a third-party actor to succeed. All four blockchain experts are certain that a third-party actor is needed to ensure initial trust in the implementation process, and the blockchain experts (Magnusson and Prophet) describe that suppliers might not want to participate on a platform owned by one company, causing hesitance. Thereby, based on Vanichchinchai (2019) and Tan et al. (2018) it may be argued that the third-party actor is important in the implementation process as it enables increased trust, aligned goals, and legitimacy to the project. In addition, the blockchain expert Lindman describes that the easier the use case, the easier the blockchain implementation, meaning that the more obvious the benefits are for the parties involved, the less inter-organizational friction there would be. Therefore, the MNCs' disability to implement blockchain without a third-party is interpreted as a potential barrier to implement blockchain.

Supply chain relationships for implementation

Adding to the literature on MNCs' blockchain implementation, Volvo Cars argue that top-management commitment is pivotal for the blockchain implementation, as top management in all tiers is needed for the negotiation process leading to suppliers onboarding. Based on findings regarding how Company X influences the supply chain to implement sustainability in lower-tier, this may be argued to be similar to blockchain implementation in terms of moving down the supply chain, convince suppliers, align interests and create incentives. This is strengthened by Volvo Cars, meaning that particularly first-tier is crucial to get on board in order to collaborate with joint forces to engage the suppliers further upstream. Magnusson is in accordance with this, describing that mutual trust with the first-tier supplier is crucial to driving the process of blockchain implementation. Therefore, similarly to the study by Jensen (2002), showing that top management is important to drive sustainability. Therefore, it may be argued that top management is important in the first phase of the blockchain implementation, and that first-tier supplier participation is essential for the subsequent process. However, Volvo Trucks explain that despite that a company has greater knowledge of the supply chain, the process to work with upstream suppliers still has to be in conjunction with the first tier supplier as this is how business is conducted in the automotive industry. This indicates that it is still a time and resource-consuming process although having more information at hand.

Furthermore, as described by the MNCs (Volvo Cars and Scania), the suppliers' business might, in fact, be enhanced as a result of the blockchain implementation. These findings might be interpreted as blockchain is upskilling the suppliers, both in terms of business and knowledge. In addition, Volvo Cars, aligned with the blockchain expert Prophet, describe that blockchain can consolidate the supply chain, which according to Volvo Buses can have multiple benefits considering the complexity in automotive global supply chains. Although the majority of the MNCs' and one blockchain expert (Magnusson) agrees that it will change the supply chain network on a non-contractual level and in terms of power, the lack of responses and divergent answers indicate that it is seemingly difficult to predict more precisely how blockchain will influence the network dynamics.

Based on Meqdadi et al., (2017), there is arguably a need for both non-contractual remedies such as relationship building and trust, contractual remedies such as third-party. In the blockchain context, based on this study's findings, it is seemingly valid with regards to the use of blockchain as a governance remedy in the automotive industry's supply chains. However, similarly to the fact that Volvo Buses and Scania state that there is no universal recipe on how to build supply chain relationships, there is arguably no universal recipe on how to build relationships to succeed with blockchain implementation, although acknowledged as required to succeed. To generalize this finding further, there might not be any universal recipe on how to integrate blockchain in an MNC and its supply chain but is surely dependent on each companies' abilities and characteristics. Based on these findings, the following proposition is formulated:

P7: Blockchain has a limited positive influence on multi-tier relationship-building.

5.3.3 Blockchain Experts View on Additional Governance Changes

All four blockchain experts are in accordance with the literature that the two different blockchains, permissioned and permissionless, contribute to different governance changes in the supply chain network. However, there are divergent opinions regarding the transparency that blockchain enables in the supply chains and this has an effect on the supply chain dynamics. According to the blockchain experts (Prophet and Magnusson), there is an important difference in terms of governance if using a permissioned or permissionless blockchain technology. In detail, on a permissionless blockchain, monitoring is improved as there is a low threshold to join the network, as argued by Lindman in line with Laplume, (2018) and Biswas and Gupta (2019). Meaning that the more nodes, the higher security it is as the information is verified by a higher number of actors. The blockchain expert Magnusson describes that a common misperception is that information per se is not transparent as it is encrypted. However, there is a dual perspective on having a low threshold to participate in the permissionless blockchain. Magnusson describes this to lead to new dynamics in the supply chain, as the lock-in effect of signing long-term contracts with the suppliers' decreases. Therefore, this means that the possibility to alter suppliers dependent on different suitability needs would be enhanced, thus increasing the supply chain network dynamics on a multi-tier level. With regards to Covid-19 and the disruptions in the automotive MNCs global supply chain, as previously mentioned, could in theory, have reallocated the supply chain to more efficient terms.

On the other hand, in line with the MNCs' responses regarding long-term relationship building and product development with suppliers, emphasizing the relational aspect in the automotive industry, when the MNCs have a permissioned blockchain. This would rather increase the supplier dependency due to the large investment required to onboard suppliers, thus decreasing supply chain dynamics. Moreover, the blockchain expert Book and theory, Ghosh and Fedorowicz (2008), argue that for success, a governance system should not only benefit the MNCs but the entire supply chain. Therefore, it may be interpreted that a permissioned blockchain owned and controlled by the MNCs primarily in fact, benefits the MNCs. Thereby,

the adoption of the different characteristics of the different configurations is interpreted to be a result of the MNCs' trade-off between control and low threshold for suppliers to join the network. Based on these findings, the following proposition is formulated:

P8: The permissioned blockchain allows for remained control, while the adoption of permissionless blockchains requires the MNCs to lose control, which increases the implementation barriers to permissionless blockchains.

5.4 Blockchain Implementation Facilitators

In the empirical findings, both bargaining power, and industry collaboration emerged from the data as important aspects in relation to the automotive MNCs blockchain implementation. Therefore, these two aspects are discussed in this section in order to assess their influence on the perceived barriers to implement blockchain in the global supply chains.

5.4.1 Bargaining Power

The data shows that bargaining power is an important aspect of governing global supply chains, aligned with a theory saying that monitoring activities in a supply chain are dependent on trust and bargaining power (Ghosh and Fedorowicz, 2008). The MNCs (Volvo Cars, Scania and Volvo Trucks) data indicate that the use of coercive and strong bargaining power is important to increase transparency, particularly for specific commodities. While some companies (Company X, Volvo Cars, Volvo Group, Volvo Trucks) perceive their bargaining power to be strong, some companies (Company X, Volvo Buses, Scania and Volvo Trucks) mention this being dependent on the companies' size and volumes. Interestingly, the companies that do not describe their bargaining power as strong (Volvo Buses and Scania) are also the companies that negotiate with the entire group in order to increase bargaining power. Further, Volvo Cars mentioned that top management support is crucial when negotiating with suppliers upstream their global supply chains. Thereby, it may be interpreted as vital to ensure that the MNCs have bargaining power in the blockchain implementation process.

Further, a blockchain expert (Book) mentions that coercive power is needed when implementing a permissioned blockchain. Thereby, an 'in-our-out' negotiation is perceived as necessary to align the suppliers to the same system. On the other hand, Company X believes that it will not be able to force a supplier to join the network. This indicates that altering the status quo in the supply chain might be difficult, particularly as Volvo Cars described that suppliers might not see the value prior to implementation. This is strengthened by data, showing that half of the automotive MNCs (Volvo Cars, Scania, Volvo Trucks) believe that strong bargaining power or orders of large volumes are needed in order to succeed, during, and after implementation of blockchain. Subsequently, this indicates that negotiation and promises of large business value in a long-term perspective is increasing the likelihood of successful blockchain implementation. To nuance, Magnusson argues that in the occurrence of strong bargaining power, the MNCs can choose transparent and sustainable suppliers. This is also argued by Volvo Cars, as sub-suppliers that have bargaining power might not be willing to join the blockchain network. This is indicating that there is an interrelationship between the

bargaining power and the ability to choose suppliers to the blockchain network. However, based on the results, it should be highlighted that this remains an unexplored area, with unknown changes in the bargaining power in the supply chain post blockchain implementation. Meaning that a blockchain implementation might alter the bargaining power and impact the supply chain to a greater extent than is foreseeable today. Based on these findings, the following proposition is formulated:

P9: The MNCs' blockchain implementation barriers are dependent on the MNCs' bargaining power to govern the global supply chain.

5.4.2 Industry Collaboration

Based on the findings, there is a need for industry-collaborations, as one company alone does not have the ability to increase sub-supplier governance and increase the transparency needed to reduce information asymmetry, as argued by Company X. Thereby, this indicates that more streamlined activities and a common ground for the whole automotive industry are needed to increase information flow. Both transparency and industry collaborations are desired by all six MNCs in the study. However, solely two companies (Company X and Scania) believe that industry collaboration increases transparency, and two companies (Volvo Cars and Volvo Bus) see industry-wide collaboration as a tool to share resources to increase traceability in the supply chain. At the same time, in regard to blockchain, there is consensus among the blockchain experts that in order for MNCs' to implement blockchain, industry standardizations are essential, and Prophet explains that common standards for a system are key to create transparency. In this case, the companies are increasingly positive, as four companies (Volvo Cars, Volvo Buses, Volvo Group and Scania) mention this as important. Thereby, based on Rejeb et al. (2019) the automotive MNCs need industry-wide standards on requirements and what type of blockchain that should be used. It could thereby be argued that automotive MNCs, who share many of their sub-suppliers, are positive to collaborate on a blockchain due to the difficulty to govern the lower-tier suppliers. However, this implies that there is a greater pre-implementation process before the blockchain implementation actually can happen, meaning that the implementation has to be framed in conjunction with multiple decision-makers and stakeholders, argued by Bai and Sarkis (2020). Further, this would extend or slow down the implementation process, as stressed by Volvo Buses. On the other hand, two companies (Volvo Buses and Scania) recognize the slow negotiation process, although, stating that if it is for a greater cause, the company would be willing to.

Moreover, several MNCs (Company X, Volvo Cars and Scania) have an extensive evaluation process searching for a clear business value when selecting what industry initiative to join. One specific criterion is that it should be global initiatives rather than regional and local, due to the global characteristics of the supply chains. This implies that there is a perceived value in industry-collaboration to tackle the geopolitical differences and to increase control on a global scale, although, without prohibiting the MNCs' self-interests. At the same time, three companies (Volvo Buses, Scania, Volvo Trucks) mention confidential information as a reason to limit industry collaboration. When asked regarding information sharing on a blockchain

platform, only one company expressed that this is a barrier to intra-industry collaboration.

Despite that the companies would like to collaborate on an intra-industry level, it is arguably not unproblematic to collaborate with competitors. This may explain why the data shows an indication that cross-industry collaboration could be suitable to tackle the sub-supplier information asymmetry. Three companies (Volvo Cars, Volvo Group and Scania) mention this being pivotal to create change, as suppliers and sub-suppliers are supplying on a cross-industrial level. This implies that even though collaboration is perceived as time-consuming, the MNCs might be willing to sacrifice time rather than risking losing control of the information flow. Moreover, according to the findings, an industry-wide umbrella is arguably needed both to create common standards and to align the requirements in the industry in order to make a larger impact. The blockchain expert Book describes that industry standardization is required in order for the blockchain technology to reach momentum, meaning that the industry needs to align and ensure that there is interoperability between the different blockchains as this is where the technology is the most beneficial. As previously discussed, the MNCs are seemingly perceiving it overarchingly more beneficial to implement privately owned blockchains. Thereby, limit the interoperability between companies, subsequently limits the benefits of blockchain. On the other hand, to succeed with collaboration on a blockchain platform, there has to be a low hanging fruit for all companies to be involved. Based on these findings, the following proposition is formulated:

P10: When there is no common intra- and inter-industry standards regarding blockchain, the perceived implementation barriers increase.

6 Conclusions, Implications and Further Research

The last chapter presents the conclusion of the findings in the conducted analysis and answers the research question. Subsequent to the conclusions and contributions of the study the managerial implications and proposal for future research are presented.

6.1 Conclusions

Previous research has primarily been emphasizing the benefits that blockchain would provide to companies and it has been described that blockchain would be suitable to increase transparency in global supply chains. However, to the best of the authors' knowledge, few studies have been exploring blockchain implementation from a practical perspective, and few studies are conducted on MNCs' global supply chains and their governance systems. This has motivated this study, which contributes to knowledge of what constitutes the MNCs' perceived implementation barriers, and the feasibility of implementing new technology in global supply chains out of direct control to the MNCs. Accordingly, the central contribution of this study concerns blockchain and global supply chain governance in relation to the MNCs. This is studied in a multidimensional perspective, both out of the MNCs' motivation and challenges to use blockchain as well as out of a supply chain perspective examining the adoption barriers in relation to the supply chain governance modes. However, as a point of departure, this study has found that there are not many automotive MNCs that have adopted blockchain in supply chains. There do not seem to be any bulletproof answer to what the barriers are, as it is a highly complex area, both from a technical and operational point of view. Nevertheless, this study contributes to knowledge regarding the barriers to implement blockchain to increase transparency in automotive MNCs' global supply chains, while contributing to the research fields of blockchain and governance.

Firstly, this study extends the previous research stating that blockchain is suitable to increase transparency, leading to sustainable supply chains, as this has not been empirically investigated. This study shows that MNCs' motivation for sustainable supply chains, enabled by increased transparency, consists of institutional and stakeholder pressure. However, the motivation to adopt blockchain is only driven by stakeholder pressure when it comes to increase sustainability, thus this is not significant in this study. Therefore, the MNCs' underlying motivation for sustainability and implementation of blockchain is different, meaning that there is no obvious interrelatedness between blockchain, sustainability, and transparency for the automotive MNCs. This regardless of the fact that sustainability requires transparency and blockchain is a tool to increase transparency. Instead, there are varying underlying motivational factors as to why MNCs would increase transparency with blockchain as these are company-specific connected to supply chain governance purposes. However, these are too vague to be driving forces and the companies are lacking knowledge regarding blockchain and its enablers, meaning that there is a lack of motivation which constitutes barriers to implementing blockchain. Therefore, this study has found that transparency is not a sufficiently strong motivator when balanced with the automotive MNCs perceived blockchain implementation challenges.

However, there is a discrepancy in what the blockchain experts perceive as motivation for implementing blockchain, and how well it may solve MNCs current supply chain challenges. The blockchain experts hold an enlarged perspective on technology and its positive impact. Therefore, there might be a considerable knowledge gap, and a barrier in the sense that companies lack the experience to see what blockchain can do for their specific company, as there are inter-company variations within the automotive industry. The larger the discrepancy between the perception that blockchain may solve the current challenges, the less it is perceived as adding business value, and the larger the automotive MNCs barrier to implement blockchain. Therefore, this study is adding knowledge to prior theories regarding both global supply chain governance and supply chain sustainability with the use of blockchain, showing that MNCs do not see enough value to use blockchain as a governance tool for increasing transparency.

Secondly, this study adds knowledge to the field of MNCs' governance systems, partially contradicting prior studies that MNCs should have a multi-tier governance system. This study has shown that contractual and non-contractual remedies on a multi-tier level are needed to create more resilient and sustainable supply chains, although, currently not existing in the automotive MNCs supply chains. During the recent Covid-19 outbreak, the automotive MNCs' global supply chains have suffered significantly from disruptions and breakdowns as a result of limited governance possibilities beyond their first-tier supplier. The findings in the study show that to implement blockchain, companies need to incorporate a multi-tier governance perspective, meaning that MNCs should be moving from having traditional global supply chains, towards supply chain networks and supply chain partnerships. However, the study has shown that the MNCs' increasing traceability is based on perceived largest implications related to information asymmetry, which is mainly towards the critical supply chains. Thus, there are no incentives for the MNC to implement blockchain in the global supply chain to any further extent than these critical supply chains. Therefore, it may enable transparency in specific raw materials but have an insignificant impact on supply chain disruptions on the magnitude of Covid-19. Subsequently, this contributes to nuanced knowledge of global supply chain sustainability and governance with the use of blockchain.

As for the implementation process of blockchain, this study adds knowledge to the scarce research field on how new technology is implemented in a global supply chain out of direct control to the MNC. The findings indicate that managers are pivotal for the initial phase, and it is important to have a solid relationship with the first-tier supplier and a sophisticated supply chain planning, which is a barrier today as managers lack knowledge of the technology, as previously stated. This study's results show that blockchain is beneficially implemented in new supply chains, meaning that the lack of transparency in existing complex global supply chains is prohibiting implementation, making the implementation process overwhelmingly recourse consuming. In this study, the perspective of suppliers' incentives, willingness, and skill set that enables them to participate in a blockchain is constituting large implementation barriers for the automotive MNCs. Consequently, moving upstream the supply chain geopolitical gaps influences the implementation barriers and might require large investments, both monetary, time, and relational resources. MNCs' current governance system is based on valuable

relationships and product development with the first-tier supplier. However, to implement blockchain, this is required on a new level, as different supplier standards require knowledge gap minimizing, upskilling, and increased infrastructure capabilities. Thereby making the question of multi-tier development relevant. This is significantly different from how MNCs are working today, meaning that it is requiring a multi-dimensional and multi-tier perspective, thus enlarging the implementation barriers. Therefore, the findings show, apart from the directly MNC-related implementation barriers, that there are implementation barriers related to the supply chain governance system. Thereby, it is not the technical aspects that are constituting the main barriers, as the possibility to solve interoperability and data input reliability is increasing, it is rather the inter-organizational aspects. Partly in contrast to prior research, it cannot be stated with certainty that blockchain may, in fact, suit automotive global supply chains as there are many barriers related to the specific industry characteristics of the global supply chains.

Thirdly, this study also provides additional knowledge of global supply chain governance, arguing that bargaining power and industry-wide umbrellas, thus intra-industry collaboration and industry-wide standards are required to govern the MNCs' global supply chain and implement blockchain. This may be assumed to be equal for implementation of any technology and governance system. The findings show that industry collaboration is arguably increasing norms and institutional pressure to increase transparency to remain legitimate. Thus, influencing the governance modes and also blockchain adoption. Furthermore, bargaining power allows the MNC to choose the suppliers to participate in the blockchain. Therefore, the automotive MNCs with less bargaining power and weaker industry collaboration will perceive the barriers to implement blockchain higher. Accordingly, this study has enhanced knowledge of the underlying determinants to use blockchain to increase transparency, contributing to blockchain and global supply chain governance theories.

6.2 Managerial Implications

This thesis has outlined new insights into the main barriers to implementing blockchain in automotive MNCs' global supply chains to increase transparency. After completing this study, it is argued that the barriers revealed should be of interest to managers of automotive MNCs, and three main managerial implications are proposed from the gained insights. The first implication is based on the fact that transparency is a key driver to enhance resilience in the global supply chain, operational performance, and allows for greater decision-making. Blockchain is argued to provide significant capabilities, however, each specific company needs to discover company-specific business-value. Therefore, it is suggested to experiment broadly together with third-party in order to discover and solve existing challenges with the new technology in a holistic view, incorporating the entire company. The second implication is based on the argument that lack of knowledge increases the risk that the company is not capturing the value of blockchain if it is only altering one system to another. Therefore, continuous upskilling of the staff, avoid thinking in silos, and stimulation of an innovative, adaptive mindset in global supply chain governance is required. The third managerial implication is related to the resources that are needed to establish new multi-tier governance

patterns, which are important pre, during, and post blockchain implementation. It is of importance to be embedded within good business relations with both existing and new suppliers as well as industry-collaborations, as aligned goals, standards, and infrastructure in conjunction with a sophisticated development plan decrease the barriers to implement new technology in the global supply chain.

6.3 Further Research

This study is contributing with knowledge regarding the MNCs' implementation barriers to use blockchain with the purpose to increase transparency in global supply chains, however there are several suggestions for further research within the field of MNCs global supply chain governance and blockchain. In addition to the constraints of this study using a limited sample size within the automotive industry, the abductive research approach does not allow for statistical inference. Therefore, the propositions that have been developed could, therefore, be tested and validated in a larger sample in the form of a hypothesis to provide statistically established conclusions in future research and this is needed to extend the generalizability. Another way to extend generalizability is to compare the barriers to implement blockchain with other multi-tier supply chain solutions to see if the findings are generalizable on an inter-technological scale. Considering the novelty in this research field, this would provide further knowledge, contributing to knowledge regarding MNCs multi-tier supply chain governance to achieve sustainable supply chains.

Moreover, as argued in the study, blockchain requires a corporate holistic view on implementation. Therefore, extending this study to include several divisions in a firm with different views on how blockchain would create value and what the barriers are, would provide greater knowledge in a larger perspective, as there might be implementation barriers in other parts of the company, such as legal aspects. This would strengthen the literature on blockchain from a business perspective further, rather than a technical view, as this is likely to be needed in the future. Subsequently, the analysis model proposed in this study may be extended and developed in more detail. In addition, as the MNCs in the study have a very low rate of blockchain implementation to this date, it would be interesting to study further how the MNCs implementation barriers and global supply chain governance are developing. Especially, if the compatibility or challenges to adopting blockchain in automotive MNCs are increasing over time with an increasing degree of implementation and maturity level. Further, if the barriers potentially could change as the MNCs gain insight into prerequisites and the technology itself, as this study found a large technological knowledge gap in general.

Lastly, this study was conducted in the automotive industry, including the perspective of western European MNCs. However, considering the finding that a bottleneck to implementing blockchain lies in the suppliers' incentives, willingness, and level of maturity, it would be of interest to conduct a similar study out of a supplier or subsidiary perspective. This would provide an understanding of the MNCs' geopolitical implementation barriers, adding to the research field of international business and global supply chain governance.

7 References

Abdullah, Z., & Musa, R. (2014). The effect of trust and information sharing on relationship commitment in supply chain management. *Procedia-Social and Behavioral Sciences,* 130, 266-272.

Angelis, J., & da Silva, E. R. (2019). Blockchain adoption: A value driver perspective. *Business Horizons*, 62(3), 307-314.

Ahmed, W., & Omar, M. (2017). Drivers of supply chain transparency and its effects on performance measures in the automotive industry: case of a developing country. *International Journal of services and operations management*.

Astill, J., Dara, R. A., Campbell, M., Farber, J. M., Fraser, E. D., Sharif, S., & Yada, R. Y. (2019). Transparency in food supply chains: A review of enabling technology solutions. *Trends in Food Science & Technology*.

Aydin, G., Cattani, K., & Druehl, C. (2014). Global supply chain management. *Business Horizons,* 57(4), 453-457.

Azzi, R., Chamoun, R.K. & Sokhn, M., 2019. The power of a blockchain-based supply chain. *Computers & Industrial Engineering,* 135, pp.582–592

Bai, C. A., Cordeiro, J., & Sarkis, J. (2020). Blockchain technology: Business, strategy, the environment, and sustainability. *Business Strategy and the Environment*, 29(1), 321-322.

Bai, C. & Sarkis, J. (2020): A supply chain transparency and sustainability technology appraisal model for blockchain technology, *International Journal of Production Research*, DOI: 10.1080/00207543.2019.1708989

Baralla, G., Ibba, S., Marchesi, M., Tonelli, R., & Missineo, S. (2018). A blockchain based system to ensure transparency and reliability in food supply chain. In European conference on parallel processing (pp. 379-391). Springer, Cham.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management,* 17(1), 99-120.

Bateman, A. H. (2015). Tracking the value of traceability. *Supply Chain Management Review*, 9, 8-10.

Bauman, D., Lindblom, P., & Olsson, C. (2016). *Blockchain: Decentralized trust*. Näringspolitiskt forumrapport #15. Entreprenörskapsforum. Örebro Universitet

Bentahar, O., & Benzidia, S. (2018). Sustainable supply chain management: Trends and challenges. *Transportation Research Part E*, 119, 202-204.

Bettín-Díaz, R., Rojas, A. E., & Mejía-Moncayo, C. (2018). Methodological approach to the definition of a blockchain system for the food industry supply chain traceability. *International Conference on Computational Science and Its Applications* (pp. 19-33). Springer, Cham.

Biswas, B., & Gupta, R. (2019). Analysis of barriers to implement blockchain in industry and service sectors. *Computers & Industrial Engineering*, 136, 225-241.

Boström, M., Jönsson, A., Lockie, S., Mol, A., & Oosterveer, P. (2015). Sustainable and responsible supply chain governance: Challenges and opportunities. *Journal of Cleaner Production*, 107, 1-7.

Brockhaus, S., Fawcett, S. E., Knemeyer, A. M., & Fawcett, A. M. (2017). Motivations for environmental and social consciousness: Reevaluating the sustainability-based view. *Journal of Cleaner Production*, 143, 933-947.

Bryman, A., & Bell, E. (2019). *Business research methods*. Fifth edition. Oxford University Press, Oxford.

Bubicz, M. E., Barbosa-Póvoa, A. P. F. D., & Carvalho, A. (2019). Incorporating social aspects in sustainable supply chains: Trends and future directions. *Journal of Cleaner Production*.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: Moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38(5), 360–387.

Chaudhuri, A., Boer, H., and Taran, Y. (2018). Supply chain integration, risk management and manufacturing flexibility. *International Journal of Operations & Production Management,* Vol. 38(3), pp. 690-712.

Chen, S. (2018). Multinational corporate power, influence and responsibility in global supply chains. *Journal of Business Ethics*, 148(2), 365-374.

Cole, R., Stevenson, M., & Aitken, J. (2019). Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*, 24(4), 469-483.

Deloitte (2020). Covid 19, Managing supply chain risk and disruption. Accessed 2020-03-26. Retrieved from: www.deloitte.com

D'Eusanio, M., Zamagni, A., & Petti, L. (2019). Social sustainability and supply chain management: Methods and tools. *Journal of Cleaner Production*, 235, 178-189.

DiMaggio, P., & Powell, W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160.

Eisenhardt, K. (1989a). AGENCY THEORY - AN ASSESSMENT AND REVIEW. *Academy of Management Review*, 14(1), 5-74.

Eisenhardt, K. M. (1989b). Building Theories from Case Study Research, *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550

Egels-Zandén, Niklas, Hulthén, Kajsa, & Wulff, Gabriella. (2015). Trade-offs in Supply Chain Transparency: The Case of Nudie Jeans Co. *Journal of Cleaner Production*, 2015, Vol. 107, pp.95-.104, 107, 95-104.

Everledger (2020). Industry Solutions: E-recycling. Accessed 2020-03-16. Retrieved from: www.everledger.io

Eriksson, P., & Kovalainen, A. (2014). Qualitative Methods in Business Research. Second edition. Los Angeles: SAGE

European Commission (EC) (2017). The Regulation Explained. Accessed: 2020-03-26 Retrieved from: www.ec.europa.eu

EU Science Hub (2020). Raw Materials Information System (RMIS). Accessed. 2020-03-26. Retrieved from: www.rmis.jrc.ec.europa.eu/

Fayezi, S., O'Loughlin, A., & Zutshi, A. (2012). Agency theory and supply chain management: A structured literature review. *Supply Chain Management: An International Journal*, 17(5), 556-570.

Formentini, M., & Taticchi, P. (2016). Corporate sustainability approaches and governance mechanisms in sustainable supply chain management. *Journal of Cleaner Production*, 112(P3), 1920-1933.

Ghosh, A., & Fedorowicz, J. (2008). The role of trust in supply chain governance. *Business Process Management Journal*.

Gold, S., & Schleper, M. C. (2017). A pathway towards true sustainability: A recognition foundation of sustainable supply chain management. *European Management Journal*, 35(4), 425-429.

Goldstein, B., & Newell, J. P. (2020). How to track corporations across space and time. *Ecological Economics*, 169, 106492.

Govindan, K., Seuring, S., Zhu, Q., & Azevedo, S. (2016). Accelerating the transition towards sustainability dynamics into supply chain relationship management and governance structures. *Journal of Cleaner Production*, 112, 1813-1823.

Grimm, J. H., Hofstetter, J. S., & Sarkis, J. (2014). Critical factors for sub-supplier management: A sustainable food supply chains perspective. *International Journal of Production Economics*, 152, 159-173.

Grimm, J.H., Hofstetter, J.S., Sarkis, J., 2016. Exploring sub-suppliers compliance with corporate sustainability standards. *Journal of Cleaner Production*. Prod. 112, 1971e1984.

Harvard Business Review, HBR (2017). 80% of Companies Don’t Know If Their Products Contain Conflict Minerals. Accessed: 2020-02-24. Retrieved from: www.hbr.org

Harvard Business Review, HBR (2019). What Supply Chain Transparency Really Means. Accessed: 2020-02-24. Retrieved from: www.hbr.org

Harvard Business Review, HBR (2020). Coronavirus is proving that we need more resilient supply chains. Accessed: 2020-03-26. Retrieved from: www.hbr.org

Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, 49, 114-129.

Hutchins, M.J. and Sutherland, J.W. (2008), "An exploration of measures of social sustainability and their application to supply chain decisions", *Journal of Cleaner Production*, Vol. 16 No. 1, pp. 1688-1698.

Huq, F.A., Stevenson, M., Zorzini, M. (2014) Social sustainability in developing country suppliers: an exploratory study in the ready-made garments industry of Bangladesh. *International Journal of Operations Production Management*., 34 (5), pp. 610-638

Huq, F.A., Stevenson, M. (2020). Implementing Socially Sustainable Practices in Challenging Institutional Contexts: Building Theory from Seven Developing Country Supplier Cases. *Journal of Business Ethics*. 161, 415–442.

Ivarsson, I. and Alvstam, C.G. (2009), "Learning for foreign TNCs: a study of technology upgrading by local suppliers to AB Volvo in Asia and Latin America", *International Journal of Technology Management*, Vol. 48 No. 1, pp. 56-76.

Jensen (2002), Value maximization, stakeholder theory and the corporate objective function, *Business Ethics Quarterly*, 12, 2, 235-256.

Jensen, M., & Meckling. W. (1976) Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*. 3, 305-360

IMD (2019). *RFID: Yesterdays Blockchain*. Accessed 2020-03-16. Retrieved from: www.imd.org

Kanter, R. (2011). How Great Companies Think Differently. *Harvard Business Review*, 89(11), 66.

Kano, L. (2018). Global value chain governance: A relational perspective. *Journal of International Business Studies*, 49(6), 684-705.

Kamath, R. (2018). Food traceability on blockchain: Walmart's pork and mango pilots with IBM. *The Journal of the British Blockchain Association*, 1(1), 3712.

Kim, Y. H., & Davis, G. F. (2016). Challenges for global supply chain sustainability: Evidence from conflict minerals reports. *Academy of Management Journal*, 59(6), 1896-1916.

Kitzmueller, M., & Shimshack, J. (2012). Economic Perspectives on Corporate Social Responsibility. *Journal of Economic Literature*, 50(1), 51-84.

Koberg, E., & Longoni, A. (2019). A systematic review of sustainable supply chain management in global supply chains. *Journal of cleaner production*, 207, 1084-1098.

Korpela, K., Hallikas, J., & Dahlberg, T. (2017). Digital supply chain transformation toward blockchain integration. In proceedings of the 50th Hawaii international conference on system sciences.

Kshetri, N. (2018). 1 Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, 39, 80-89.

Laplume, A. (2018). "Blockchain Ventures and International Business", van Tulder, R., Verbeke, A. and Piscitello, L. (Ed.) *International Business in the Information and Digital Age* (*Progress in International Business Research, Vol. 13*), Emerald Publishing Limited, pp. 141-157.

Leire, C., & Mont, O. (2010). The implementation of socially responsible purchasing. *Corporate Social Responsibility and Environmental Management*, 17(1), 27-39.

Li, X., Li, H., & Xie, L. (2019). Indirect effect mechanism of supply chain relationship quality on supply chain performance. *International Journal of Internet Manufacturing and Services*, 6(2), 155-168.

Liu, G. (2018). The Impact of Supply Chain Relationship on Food Quality. *Procedia Computer Science*, 131, 860-865.

Liu, L., Zhang, M., Hendry, L. C., Bu, M., & Wang, S. (2018). Supplier Development Practices for Sustainability: A Multi-Stakeholder Perspective. *Business Strategy and the Environment,* 27(1), 100-116.

Longo, F., Nicoletti, L., Padovano, A., d'Atri, G., & Forte, M. (2019). Blockchain-enabled supply chain: An experimental study. *Computers & Industrial Engineering*, 136, 57-69.

Lu, Q., Meng, F., & Goh, M. (2014). Choice of supply chain governance: Self-managing or outsourcing? *International Journal of Production Economics*, 154, 32-38.

Mani, V., Agrawal, R., & Sharma, V. (2015). Social sustainability in the supply chain: analysis of enablers. Manag. Res. Rev, 38(9).

Mani, V., Gunasekaran, A., & Delgado, C. (2018). Supply chain social sustainability: Standard adoption practices in Portuguese manufacturing firms. *International Journal of Production Economics,198*, 149-164.

Mani, V., Gunasekaran, A., Papadopoulos, T., Hazen, B., & Dubey, R. (2016). Supply chain social sustainability for developing nations: Evidence from India. *Resources, Conservation & Recycling*, 111(C), 42-52.

Marshall, D., McCarthy, L., Claudy, M., & McGrath, P. (2019). Piggy in the Middle: How Direct Customer Power Affects First-Tier Suppliers' Adoption of Socially Responsible Procurement Practices and Performance. *Journal of Business Ethics*, 154(4), 1081-1102.

Mayrhofer, U., & Prange, C. (2015). Multinational Corporations (MNC s) and Enterprises (MNE s). *Wiley encyclopedia of management*, 1-5.

Meqdadi, O., Johnsen, T. E., & Johnsen, R. E. (2017). The role of power and trust in spreading sustainability initiatives across supply networks: A case study in the bio-chemical industry. *Industrial Marketing Management*, 62, 61-76.

Miemczyk, J., & Luzzini, D. (2019). Achieving triple bottom line sustainability in supply chains. *International Journal of Operations & Production Management, 39*(2), 238-259.

Moktadir, A., Rahman, T., Jabbour, C. J. C., Ali, S. M., & Kabir, G. (2018). Prioritization of drivers of corporate social responsibility in the footwear industry in an emerging economy: A fuzzy AHP approach. *Journal of cleaner production*, 201, 369-381.

Montecchi, M., Plangger, K., & Etter, M. (2019). It's real, trust me! Establishing supply chain provenance using blockchain. *Business Horizons*, 62(3), 283-293.

Nakamoto, S. 2008. "Bitcoin: A Peer-to-Peer Electronic Cash System." (PDF).

Nassar, S., Kandil, T., Er Kara, M., & Ghadge, A. (2019). Automotive recall risk: Impact of buyer–supplier relationship on supply chain social sustainability. International Journal of Productivity and Performance Management, *International Journal of Productivity and Performance Management*, 2019.

Norberg, H. C. (2019). Unblocking the bottlenecks and making the global supply chain transparent: How blockchain technology can update global trade. *The School of Public Policy Publications*, 12.

OECD. (2019). *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.* Third Edition. (PDF)

Pan, X., Pan, X., Song, M., Ai, B., & Ming, Y. (2019). Blockchain technology and enterprise operational capabilities: An empirical test. *International Journal of Information Management*.

Ping-Kuo, C., & Ye, Y. (2019). Factors for improving and moderating a successful supply chain. *Journal of Business Economics and Management*, 20(1), 20-42.

Qiao, J., Niu, Y., Kifer, T., Fernández-Martínez, M., L.G. Guirao, J. (2018) Intelligent optimization algorithm for global convergence of non-convex functions based on improved fuzzy algorithm. *Journal of Intelligent & Fuzzy Systems* 35:4, pages 4465-4473.

Queiroz, M.M. & Wamba, S.F., (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, 46, pp.70–82.

Rindfleisch, A. and Heide, J.B. (1997), "Transaction cost analysis: past, present, and future applications", *Journal of Marketing*, Vol. 61 No. 4, pp. 30-54.

Roeck, D., Sternberg, H., & Hofmann, E. (2019): Distributed ledger technology in supply chains: a transaction cost perspective, *International Journal of Production Research*, DOI: 10.1080/00207543.2019.1657247

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019) Blockchain technology and its relationships to sustainable supply chain management, *International Journal of Production* Research, 57:7, 2117-2135, DOI: 10.1080/00207543.2018.1533261

Silvestre, B. S., Monteiro, M. S., Viana, F. L. E., & de Sousa-Filho, J. M. (2018). Challenges for sustainable supply chain management: When stakeholder collaboration becomes conducive to corruption. *Journal of Cleaner Production*, 194, 766-776.

Schmidt, C., & Wagner, S. (2019). Blockchain and supply chain relations: A transaction cost theory perspective. Journal of Purchasing and Supply Management, 25(4), *Journal of Purchasing and Supply Management*, October 2019, Vol.25(4).

Shi, Y. W., Chen, P. K., & Ye, Y. (2019). Factors for improving and moderating a successful supply chain. *Journal of Business Economics and Management*, 20(1), 20-42.

Sodhi, M., & Tang, C. (2019). Corporate social sustainability in supply chains: A thematic analysis of the literature. *International Journal of Production Research*, 56(1-2), 882-901.

Song, M., Chen, M., & Wang, S. (2018). Global supply chain integration, financing restrictions, and green innovation. *The International Journal of Logistics Management*, 29(2), 539-554.

Tan, B., Yan, J., Chen, S., & Liu, X. (2018). The impact of blockchain on food supply chain: the case of Walmart. In International Conference on Smart Blockchain (pp. 167-177). Springer, Cham.

Tannous, K., & Yoon, S. (2018). Summarizing Risk, Sustainability and Collaboration in Global Supply Chain Management. *International Journal of Supply and Operations Management*, 5(2), 192-196.

Thomsen, S., & Pedersen, T. (2000). Ownership structure and economic performance in the largest European companies. *Strategic Management Journal*, 21(6), 689-705

Thun, J., & Hoenig, D. (2011). An empirical analysis of supply chain risk management in the German automotive industry. *International Journal of Production Economics*, 131(1), 242-249.

UN Global Compact (n.d.). Advancing Sustainable Development. Accessed: 2020-01-07 Retrieved from: www.unglobalcompact.org

UNCTAD (2020). Coronavirus outbreak has cost global value chains $50 billion in exports. Accessed: 2020-03-24. Retrieved from: www.unctad.org

Vanichchinchai, A. (2019). Exploring organizational contexts on lean manufacturing and supply chain relationship. *Journal of Manufacturing Technology Management*.

Venkatesh, V., Kang, K., Wang, B., Zhong, R., & Zhang, A. (2020). System architecture for blockchain based transparency of supply chain social sustainability. *Robotics and Computer-Integrated Manufacturing,* June 2020, Vol.63.

Villena, V., & Gioia, D. (2018). On the riskiness of lower-tier suppliers: Managing sustainability in supply networks. *Journal of Operations Management*, 64(1), 65-87.

Vosooghidizaji, M., Taghipour, A., & Canel-Depitre, B. (2019). Supply chain coordination under information asymmetry: a review. *International Journal of Production Research*, 1-30.

Wamba, S. F., & Queiroz, M. M. (2020). Blockchain in the operations and supply chain management: Benefits, challenges and future research opportunities.

Weforum (2020). Coronavirus and global supply-chains. Accessed: 2020-03-24. Retrieved from: https://weforum.org

Weygand, R., Rebovich, Donald, & Starrett, Paul. (2019). Refining the Kimberley Process: An Analysis of the Certification Scheme's Failings and Exploration of Blockchain Technology as a Solution, ProQuest Dissertations and Theses.

Wiengarten, F., Humphreys, P., Cao, G., Fynes, B. and McKittrick, A. (2010), "Collaborative supply chain practices and performance: exploring the key role of information quality", *Supply Chain Management: An International Journal*, Vol. 15 No. 6, pp. 463-473.

Wong, L., Leong, L., Hew, J., Tan, G., & Ooi, K. (2020). Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs. *International Journal of Information Management*, June 2020, Vol.52.

Yin, R.K. (2018). *Case Study Research and Applications: Design and Methods.* 6th ed., London: Sage

Yong-Shin, K., Kim, H., & Yong-Han, L. (2018). Implementation of an RFID-Based Sequencing-Error-Proofing System for Automotive Manufacturing Logistics. Applied Sciences, 8(1), 109.

Zorzini, M., Hendry, L. C., Huq, F. A., & Stevenson, M. (2015). Socially responsible sourcing: Reviewing the literature and its use of theory. *International Journal of Operations & Production Management*, 35(1), 60–109**.**

8 Appendix

8.1 Appendix A: E-mail

Dear,
We are two students, Ida Söderlund and Josefin Dahlbäck, from the School of Business, Economics and Law at the University of Gothenburg, Sweden, studying the MSc in International Business and Trade. We are currently writing a master thesis about the Blockchain technology in the automotive MNC's global supply chains.

Our study is collecting information from MNC's within the automotive industry, as well as experts within the Blockchain technology to gain insight and knowledge of your global supply chains. The aim is to understand if the Blockchain technology is of value to implement in MNC's global supply chains for a transparency purpose, as the technology is said to transform and give radical improvements within the supply chain.

Thereby, we would like to get in touch with persons of strategic insights and knowledge of motivation, challenges and supply chain governance. The persons can have experience of working with procurement, sustainability in global supply chains or technology implementations and strategy. In particular, the person does not need to have knowledge about blockchain, but rather provides information and knowledge about the supply chain process.

We sincerely hope you or any of your colleagues can be available. Please reach back to us with a suitable time and date for your convenience. The estimated duration of an interview is 60 minutes. Do not hesitate to reach back for any questions.

Thank you in advance!
All the best,

8.2 Appendix B: Interview Guides

Interview guide for blockchain experts

The interviews were conducted by asking open-ended questions, initially to get general information, in order to increase the possibilities of new findings for blockchain's compatibility in MNC's global supply chains. Further the questions were asked regarding technical functions, motivation, challenges and implementation aspects. If the answers to the open-ended questions did not bring up information within these themes specific follow-up questions were asked.

General information
• Could you give a short presentation about yourself and what kind of experience/knowledge you have of blockchain technology?
Blockchain in global supply chains
Technical functions
• What are your thoughts about blockchain in supply-chains? • What are the usages of blockchain in upstream supply chains, from the raw material extraction to the finalization of the product? • How much and what information can be stored in the blockchain for a supply-chain purpose? • Advantages and disadvantage to have permissioned or permissionless blockchain in supply chains? • How does blockchain enable traceability and transparency in the global supply chain?
Motivation to the use of blockchain
• What is the motivation to use blockchain in supply chains? • What kind of blockchain technology do you think will be the most suitable for global supply chains? • Any thoughts regarding the automotive industry specifically? • What enablers do you see of using blockchain within the automotive supply chains? • What value do you see blockchain can bring to achieve sustainable supply-chains? • What is the perceived usefulness of having blockchain for a transparent register, which containing details of the production and the ability to track a product throughout the entire supply chain, from raw material to end-consumer?
Blockchain challenges
• What problems/limitations do you see of using blockchain within global supply chains? • Do you believe there any specific barriers within the automotive industry?
Implementation aspects
• How come that companies, in general, have not been implementing blockchain to any broader extent? • How is the implementation of blockchain affecting organizations from a broad perspective? • What kind of efforts does an organization need to do in order to successfully implement blockchain in the supply chain? • What values would it bring to implement the technology upstream supply chains? • Do you believe we will see the technology on the market in a broader extent, how and when? • Finally, do you have any thoughts you would like to add?

Interview guide for automotive MNC's

The MNC interview guide has been divided into six themes. The first four themes gathered knowledge of their current global supply chains, where the two last themes created an understanding of a desired global supply chain future. All respondents were asked to focus on upstream suppliers when the word, global supply chain, was brought up. By the global supply chain, we mean all activities taking place from the start of the chain until the product arrives at the company, which does not include distribution to the end-consumer. The question was open-ended, and some follow-up questions were asked when needed in order to get full answers.

General information
• Could you give a short presentation about yourself and what kind of experience/knowledge you have of global supply chains?
Current global supply chains
MNC's motivation and challenges
Motivation for sustainability and transparency
• What is your company's motivation to engage in sustainable supply chain management? • What are sustainable supply chains for you? • How do you streamline social sustainability practices in global supply chains? • What is supply chain traceability versus transparency for you? • How is knowledge gathered of your upstream supply chain? • What do you need to ensure to create transparency of materials and products in upstream supply chains? • What is important when implementing a transparency system in supply chains?
Challenges in global supply chains
• What are your current and future challenges in your global supply chains? • How do you govern to overcome these challenges? • How do you collaborate with other organizations to overcome the challenges?
Global supply chain governance
Contractual governance
• What do you think about supply chain governance? • What factors are characterizing supply chain governance? • What is effective supply chain management for your company? • What actions have you taken today to improve sub-supplier governance? • What are your perceptions of influencing suppliers that are not in direct control of the MNC? • What formal practices are relevant to make well-informed decisions regarding suppliers?
Non-contractual governance
• How would you build relationships to integrate/implement a new system? • What is your opinion on supply chain initiatives? • What is your opinion on inter-organizational collaboration in supply chain governance? • What is soft decision-making in supply chains to you? • How is decision-making conducted in your company regarding the supply chains? • What is your perception of your company's bargaining power in the supply chain, regarding all upstream suppliers?
Blockchain facilitators
Utopia

- In a perfect world, how would your supply chains be managed?
- What resources and capabilities are needed to implement this described utopia in your global supply chains?
- What are the perceived shortcomings in implementing a system for increased traceability/transparency?

Technology implementation

- What is blockchain for you?
- If you have any pilot/implementation of blockchain today, could you describe more?
- What is the perceived usefulness of having a transparent register containing details of the production and the ability to track a product throughout the entire supply chain?
- What value would blockchain or another technology bring to enhance traceability?
- What kind of resources/capabilities you as a company need in order to implement blockchain?
- What do you believe would be some barrier to implement blockchain in your supply chain today?
- How do you believe blockchain would transform collaboration and relationship in your global supply chains?
- How do you believe blockchain would transform formal governance building in your global supply chains?

- Finally, do you have any thoughts you would like to add?