# Digital supplier platform, how to stimulate sub-tier supplier involvement?

Author: Stan Lettink
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

**ABSTRACT,**
***Driving forces such as global megatrends and public initiatives are pressuring firms to change their current way of supply chain management. There is an increasing need to go beyond the original dyadic buyer-supplier relationships and move into multi-tier SCM. The involvement of sub-tier suppliers in multi-tier information sharing initiatives such as a digital supplier platform is perceived as a difficult task due to a lack of contractual agreements. This study analyzed the importance of the different barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing within the automotive industry. This research shows that cultural barriers such as trust and inter-firm relationships are perceived as the most important challenge. Information utilization factors and business process aspects are also perceived as major barriers in the automotive industry. Lastly, practical methods and strategies to overcome the barriers were identified. Providing flexibility in supporting data inputs on the platform, as well as the development of a communication strategy to market the platform and make sub-tier suppliers aware of benefits, are introduced as useful methods and strategies to overcome some of the challenges.***

**Graduation Committee members: Prof. H. Schiele, Dr. Niels Pulles**

**Keywords**
Sub-tier supplier involvement, supply chain information sharing, multi-tier supply chain management, supply chain collaboration, multi-tier information sharing, multi-tier supply chain collaboration

*This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.*

CC-BY-NC

# 1. INTRODUCTION

In the past years, the automotive supply chains have been under an increasing pressure to change. The large-scale adoption of electric vehicles, as well as a political and societal call for sustainable production, requires a new way of working for all partners within the industry (Casper & Sundin, 2020, pp. 1-2; Vanalle et al., 2011, pp. 338-339). In addition to that, the expanding amount of global supply chain disruptions demand another way of risk management. We have recently seen it with the outbreak of COVID-19 and the resulting supply chain disruptions that illustrated the vulnerability of our global chains (Wang-Mlynek & Foerstl, 2020, p. 465).

The automotive industry developed during the 20th century as a reference for all other industry sectors. Especially in terms of supply chain management due to its early move to worldwide sourcing and production (Pires & Neto, 2008, pp. 328-329). To meet those past industry needs, a German automotive manufacturer (company X), with a revenue of over 100 billion euros, developed a single online platform to communicate with its worldwide supplier base. Over the years this B2B platform (named Platform A afterward) has grown substantially. Platform A is developed as a single point of contact for all brands and all suppliers. Supplier interviews have revealed that good user management and high performance of the system are seen as strengths of platform A. However, internal discussions revealed that platform A is unlikely to be able to meet future requirements such as automation, collaboration, and transparency which is driven by global megatrends. Therefore , this is leading to the need for the development of a new digital supplier platform (named platform X afterward).

## 1.1 Global megatrends as a driving force

### *1.1.1 Sustainability awareness as a global megatrend*

Sustainability has become a growing concern in the eyes of society. Due to the limited availability of natural resources, an increase in CO2 emission, and an increasing world population, customers have become more aware of the environmental impact of the products that they buy (Rebs et al., 2019, p. 1266). This growing awareness pressures companies to reduce their carbon footprint. While this often brings costs, it can also advantage the organization. The ability to offer your products in a sustainable way can lead to an improved brand image (Yadav et al., 2016, p. 406). The authors also concluded that firms with good environmental performance are preferred by investors. Furthermore, they experience significant revenue growth due to increased sales derived from their improved brand image (Ruf et al., 2001, pp. 144, 152-153). Numerous ways to assess a firm's environmental performance have been developed in recent years. The calculation of an organization's carbon footprint is seen by stakeholders as one of the most attractive indicators. But despite that, Liu (2015, pp. 411-412) note that the calculation of the carbon footprint is a complex task, it requires a thorough calculation, and information about the entire supply chain of a product is needed. However, with the current SCM practices in the industry, the accurate calculation of the carbon footprint remains a difficult task.

During the past decade, the established automotive manufacturers have already improved their environmental performance significantly with the adoption of lean production principles. Lean techniques such as value-stream mapping and its synergies with environmental management techniques such as life-cycle assessment helped to assess environmental performance (Sobral et al., 2013). But while their focus was traditionally on themselves and their first tier-suppliers (Zhu et al., 2013, p. 114). Dou et al. (2018, p. 95) note that the increasing pressure from stakeholders requires them to go beyond organizational boundaries into multi-tier supply chain management. Especially because “the most serious environmental and social issues in the supply chain are often generated by suppliers located in the second tier or further upstream, also referred to as “lower-tier” suppliers” (Tachizawa & Wong, 2014, p. 643).

### *1.1.2 Supply chain disruptions as a global megatrend*

Another trend that can be recognized is the increasing amount of supply chain disruptions. Due to the globalization of markets, supply chains are increasingly exposed to risks that result in supply uncertainty (Vanalle et al., 2020, p. 783). A recent example is the COVID-19 pandemic, which affected the supply chains in numerous ways. Suppliers manufacturing capacities were often reduced due to lockdown regulations. Also the worldwide transportation of goods faced challenges due to border regulations (Chowdhury et al., 2021, p. 2). Furthermore, Ivanov and Dolgui (2020, p. 2911) note that the sudden increase in demand, and simultaneously the reduction in production capacity as experienced during the pandemic, are likely to cause bullwhip effects. Bullwhip effects can bring increased costs such as costs associated with excessive upstream inventory or hiring and firing of the workforce (Wang & Disney, 2016, p. 691). Another recent example is the blockage of the Suez canal by a large container ship. It resulted in over 300 delayed container ships causing supply chain disruptions in several industries, including the automotive sector (Steers, 2021).

### *1.1.3 The implementation of industry 4.0 as a global megatrend*

A third trend that can be identified is the implementation of Industry 4.0 and its prerequisites within the automotive industry. Digital data sharing and collaboration across organizational boundaries is a key aspect here. (Muller et al., 2020, pp. 1-2). Tjahjono et al. (2017, p. 1181) identified increased flexibility, efficiency, and productivity as clear benefits resulting from the implementation of Industry 4.0. Many of the benefits can only be created through transparency and promoting the supplier's willingness to share data. According to Muller et al. (2020, p. 9), this requires a new way of supply chain management where IT links with lead firms and N-tier suppliers are optimized, and data sharing can be automated.

To summarize, global trends such as the increasing sustainability awareness, increasing global supply chain disruptions, and the implementation of Industry 4.0 aspects such as automation and artificial intelligence are pressuring the automotive supply chains to change. A new way of supply chain management is needed whereby transparency is central. They call for a way of multi-tier supply chain management (Sauer & Seuring, 2019, p. 31; Thome et al., 2014, p. 91).

## 1.2 Public initiatives as a driving force

### *1.2.1 Supply chain legislation as a public initiative*

Public initiatives such as the introduction of new SC legislation are also pressuring companies to rethink their supply chain strategy. The UN Guiding Principles on Business and Human Rights introduced the human rights due diligence concept. It is based on 3 pillars (Zamfir, 2020, p. 2):

- The state duty to protect human rights
- The corporate responsibility to respect human rights
- Access to remedy for victims of business-related abuses

It is concerned with the identification, prevention, and mitigation of (potential) adverse human rights impacts, that an organization is involved with due to its own activities or those of actors in its supply chain. The UN Guiding Principles also introduced the concept of accountability. Meaning, firms can be held accountable for human rights violations (Smit et al., 2020, pp. 1-2). But the UN HRDD is not the only framework providing guidance in supply chains. More international frameworks have been introduced, for example by the Organisation for Economic Cooperation and Development Guidelines for Multinational Enterprises (OECD). The OECD guidelines provide similar standards as the UN HRDD, it focuses on activities of firms, but also activities of their direct business relationships (Ruggie, 2015, pp. 5-6). Furthermore, we are seeing that legislation, following the due diligence concepts, is now being introduced on a national level. For example, the Dutch child labour act that requires firms to determine whether child labour takes place in their supply chain, making lead firms also responsible for violations in their supply chain. While the ultimate goal of this law is to combat child labour, also other human rights violations are considered (Noti et al., 2020). Recently also Germany adopted an act on corporate due diligence in supply chains. The act requires companies with over 3000 employees to analyze human rights within their entire supply chain. They should thoroughly analyze their first-tier suppliers, but as for now, a risk analysis of human rights violations at sub-tier suppliers is only required when a company is informed about potential human rights violations. Fines could be applied when companies fail to address those risks. (Maihold et al., 2021, pp. 1-2).

In addition to those national laws, there was also a recommendation by a policy department of the EU to introduce European due diligence legislation. A European approach could be beneficial because it can guarantee a level playing field across member states. A scattered and unsymmetrical approach towards supply chain law across member states could result in less uptake of due diligence processes (Noti et al., 2020, p. 71). After this recommendation by the policy department, the EU Parliament has adopted a resolution with recommendations to the Commission on corporate due diligence and corporate accountability. The directive requires companies to carry out a risk analysis of up- and downstream business partners. As well as the implementation of a due diligence strategy to ensure that business relations act in good faith. At least once a year this due diligence strategy should be published by the company. Also, every member state is required to ensure that a civil liability mechanism is in place to hold companies liable and to consequence non-compliance (European Parliament, 2021).

Furthermore, Smit et al. (2020, pp. 6-7) mention that one of the main risks related to human rights due diligence compliance is the lack of transparency within the supply chain. HRDD compliance begins with mapping and identifying all N-tier suppliers to trace the supply chain. However, the authors note that the so-called “decoding” of supply chains is a difficult task due to an unwillingness at N-tier suppliers to share data.

### *1.2.2 VDA guidelines as a public initiative*

Another public initiative that is forcing a change in the approach towards SCM are guidelines developed by the VDA. The VDA is the Verband der Automobilindustrie which is an interest group for the German automotive industry. Automotive manufactures, as well as suppliers, are represented to safeguard interests. They are working on guidelines to optimize supply chains by initiatives such as data unification between business partners. The aim is to achieve better collaboration and communication in a more efficient and automated way (Verband der Automobilindustrie, 2020).

## 1.3 Internal targets as a driving force

Also, internal company targets at the automotive manufacturer can be recognized as a driving force to change the SCM approach. Especially sustainability initiatives and a new procurement strategy play an important role. The sustainability initiatives focus on supplier relations. The goal of the organization is to live up to its responsibility as a global manufacturer and to ensure sustainable supply chains. This initiative requires the firm to go beyond its first-tier suppliers and to develop a prevention and detection mechanism for problems within its entire supply chain. Their procurement strategy also recognizes the importance of digital collaboration and data sharing together with business partners. They realise that the needs of the future, require a more effective way of communication with their suppliers. Also, the assurance of supply remains the ultimate task for the procurement department. Which can only be achieved if there is an effective supply chain management strategy in place.

To summarize, global megatrends, public initiatives, and internal company targets are identified as driving forces to change the current supply chain management practices at the German automotive manufacturer. A new way of SCM is needed whereby N-Tier supplier transparency is crucial (Dou et al., 2018, p. 95; Muller et al., 2020, p. 9; Thome et al., 2014, p. 91).

However, one of the problems is that lead firms often have limited information about their sub-suppliers (M. M. Wilhelm et al., 2016, p. 43). The German manufacturer is trying to solve this problem by developing a digital platform where all N-tier suppliers should sign up to enable data sharing between different tiers. While the idea of this project seems promising, problems are expected. One of the main problems is the involvement of sub-tier suppliers on such a platform. M. M. Wilhelm et al. (2016, p. 43) note that lead firms are often lacking the means to exert control over their sub-tier suppliers, because no contractual relationship exists. Meaning, cooperation on the platform can not be enforced upon those suppliers. This gives rise to the research question of this thesis:

*RQ: How to stimulate sub-tier supplier involvement on a digital supplier platform?*

Answering this research question will result in a theoretical as well as a practical contribution. Theoretically, it will build upon research already done about multi-tier supply chain management. Sauer and Seuring (2019, pp. 40-41) call for more research within specific industries to develop different approaches and strategies that make sense in different contexts. This research gives insights into strategies that could stimulate sub-tier supplier involvement within the automotive industry. Practically, this study will give company X insights into how they can stimulate the involvement of their sub-tier suppliers on their newly developed platform X.

To get to an answer for our main research question, it makes sense to divide it into two parts. These are barriers and challenges towards sub-tier supplier involvement, and ways to overcome these challenges.

*RQ1.1: What are the barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing initiatives?*

*RQ1.2: What are methods and strategies to overcome those barriers and successfully involve sub-tier suppliers in information sharing initiatives?*

To answer those research questions, first, a literature review will be presented. Revolving around the concepts of N-tier supply chain transparency and supply chain collaboration. Also, a theoretical framework will be introduced which explains the

antecedents of multi-tier information sharing. In section 3, the research model will be presented which involves the antecedents of information sharing across multiple supply chain tiers. Some of the barriers are expected to be of more or less importance in the automotive industry. This section is followed by the methodology, which includes the data collection method. In section 5, the results of the interviews are described. These findings are discussed and compared to the literature in section 6. Finally, a conclusion and the recommendations to company x are presented.

# 2. THEORETICAL FRAMEWORK

## 2.1 N-Tier supply chain transparency

### *2.1.1 Definition of supply chain transparency*

Transparency, which has become increasingly important in the area of corporate performance, can be defined as the disclosure of information. Its origins can be found in right-to-know movement which was particularly present in the USA and western Europe (Mol, 2015, p. 154). We can now see it in the form of sustainability reports and other statements which are made public by organizations (Fernandez-Feijoo et al., 2014, p. 53). Only in the recent decade the term "supply chain transparency" has gained significant attention from scholars. Previously, it's importance was resisted by companies because they believed that information about suppliers naturally contained confidential information about the supplier's business processes and could erode competitive advantages (Egels-Zanden & Hansson, 2016, p. 378). Trienekens et al. (2012, p. 55) define supply chain transparency as the extent to which all stakeholders within the supply chain, have a shared understanding of, and access to, the product-related information that they request, without loss, noise, delay, and distortion. Other authors argue that it predominantly involves sustainability. Cramer (2008, pp. 399-400) for example argues that supply chain transparency is about disclosing sustainability conditions at suppliers. Egels-Zanden and Hansson (2016, p. 380) synthesize those two concepts. They note that transparency expectations on focal companies have extended into supply chains, leading to the concept of "supply chain transparency". Therefore, they define it as the disclosure of information about names and sustainability conditions of suppliers involved in making a product, and buyers purchasing practices.

Some authors also criticize the term. For example, Gold and Heikkurinen (2018, pp. 15-16) point out that the term is sensitive for abuse. They note that cases have occurred where companies were concerned with the exploitation of alleged supply chain transparency. But Gardner et al. (2019, p. 164) call for a neutral judgement of the term, they stress that supply chain transparency is "neither inherently good nor bad, and that the impact of increased transparency depends fundamentally on what information is being made transparent, how, to whom and for what purpose."

### *2.1.2 Difference between transparency and traceability*

The terms supply chain transparency and supply chain traceability are often confused by scholars and business professionals (Egels-Zanden & Hansson, 2016, p. 379). However, it is important that a clear distinction between the two terms is made. Traceability should be as seen as a transparency approach. In other words, the aim to achieve more transparency in your supply chain can be achieved by "tracing" your products and their components back up in your supply chain (Fraser et al., 2020, p. 6).

Gardner et al. (2019, p. 165) add on this by proposing a supply chain transparency framework that builds on the previously explained concepts introduced by Egels-Zanden and Hansson (2016, p. 380). They argue that SC transparency consists of six types of information: effectiveness information, policy and commitment, impact, transaction, activity, and traceability. They stress that traceability is concerned with the identification of actors and their roles, involved in the supply chain (Fraser et al., 2020, p. 6; Gardner et al., 2019, p. 165). This supports the idea that traceability should be seen as one of the "tools" to achieve supply chain transparency.

### *2.1.3 Benefits of supply chain visibility for internal stakeholders*

Visibility within the supply chain for internal stakeholders can be beneficial to an organization. It can create value by reducing the organization's exposure to supply risks, improving its environmental and social performance, and increasing operational performance by improving the supply chain's efficiency (Sodhi & Tang, 2019, pp. 2948-2949). The benefits will now be considered more in depth.

#### *2.1.3.1 Improved environmental and social performance*

Tachizawa and Wong (2014, p. 643) point out that often the most serious environmental and social issues occur at sub-tier suppliers, either second-tier or further upstream. Moreover, they note that the lack of visibility in supply chains is currently one of the main barriers towards sustainable SCM. When supply chain visibility is improved, companies can better monitor their first and sub-tier supplier base. Especially focal companies are then in the position to implement inspection and auditing mechanisms to monitor their supply chain. This gives information on how suppliers are performing and can give insights on how to prevent reputation damage which can be caused by the potential future public exposure of (sub)suppliers with unacceptable environmental or social performance (Sodhi & Tang, 2019, p. 2950). Furthermore, Dubey et al. (2020, pp. 344, 358) conclude that investments in supply chain visibility can increase environmental performance. It enables coordination within the supply chain and can show where negative environmental impact can be reduced which is caused by underperforming suppliers.

#### *2.1.3.2 Increased risk management*

As already mentioned in the introduction, the supply chains of companies are increasingly vulnerable to disruptions due to the globalization of chains (Vanalle et al., 2020, p. 783). These disruptions can be external, by way of floods and earthquakes, etc., or internal, such as supply shortages and bankruptcy at suppliers. With increased visibility, companies can develop prevention strategies against some disruptions or mitigation strategies to reduce negative impacts (Sodhi & Tang, 2019, p. 2949). Furthermore, Nooraie and Parast (2015, pp. 198-199) concluded that by implementing supply chain visibility, firms can get a better understanding of the total risks and costs involved in the supply chain. They note that proper investments in visibility mitigate the negative impacts of risks. The firms with SC visibility are able to keep costs as low as possible when a SC disruption occurs.

#### *2.1.3.3 Increased operational performance*

Bastian and Zentes (2013, p. 563) conclude that supply chain visibility can increase operational performance. As firms gain more visibility in their chains, potential ways to improve the chains could suddenly come to light. Handfield (2017, pp. 4-5), also adds that supply chain visibility could act as a starting point to pave the way for multi-tier supply chain collaboration. They point out that companies are looking for new ways to make decisions based on real-time data across the supply chain. SC

visibility could act as a first step towards multi-tier information sharing.

Along the same line, Fraser et al. (2020, p. 15) conclude that once the process of SC traceability has started, this leads to a strengthening of the relationship between the focal company and its (sub)suppliers. A stronger relationship helps to improve collaboration and communication among SC partners. Ultimately, this can make the entire SC more efficient resulting in cost savings for all actors involved.

### *2.1.4 Benefits of supply chain transparency for external stakeholders*

As already mentioned, SC transparency is about disclosing information about your supply chain to the public. This could be beneficial to the organization because it can bring them increased trust from external stakeholders, as well as make them comply with SC regulation.

#### *2.1.4.1 Compliance with regulation*

In the first chapter the different legislative initiatives which are pressuring firms to provide transparency concerning their supply chains have been introduced. For example, the human rights due diligence concept which focuses on an organization's activities as well as those of business partners (Ruggie, 2015, pp. 5-6). Also, the EU is working on regulation that requires companies to carry out a risk analysis of up- and downstream business partners as well as the implementation of a due diligence strategy (European Parliament, 2021). To comply with those regulations companies should provide SC transparency, tracing their supply chains is an important way to show that they are putting effort into due diligence acts (Smit et al., 2020, pp. 23-24; Sodhi & Tang, 2019, p. 2951).

#### *2.1.4.2 Increased trust from customers and investors*

Customers not only make decisions about products anymore solely based on price and quality. They now also consider the social and environmental norms under which the products are produced. The majority is even willing to pay a premium for products with a transparent SC. (Sodhi & Tang, 2019, pp. 2950, 2951). This does not only apply to customers, but also to investors. Firms that are environmentally and socially responsible are valued by investors (Biktimirov & Afego, 2021, pp. 9-11). This means that firms have to provide SC transparency to gain trust from customers and investors. Increased trust can ultimately lead to increased sales, or cheaper access to capital (Sodhi & Tang, 2019, p. 2951).

## 2.2 Supply chain collaboration

### *2.2.1 Definition of supply chain collaboration*

When considering again the previously introduced drivers which are pressuring the current way of SCM, we can conclude that customers and stakeholders do not differentiate between supply chain actors and the brand owner. They regard the focal company as liable for environmental and social issues in their supply chain. van Tulder et al. (2009, pp. 400-402) refer to this as the "chain liability effect". This in turn, also shifts a responsibility towards focal companies to start SC visibility or green SC initiatives. However, they cannot achieve this in isolation. When they e.g. try to increase the environmental performance of underperforming suppliers, it often leaves them with two options. Collaborate with the supplier to increase performance, or search for other suppliers. The former is mostly preferred because sustainable suppliers are scarce, and long-lasting supplier relationships are regarded to be valuable. This example shows us one of the reasons why collaboration within a supply chain is deemed important (Brun et al., 2020, pp. 6-7).

There are many views of scholars on how to define collaboration, Soosay & Hyland propose that collaboration "involves multiple firms or autonomous business entities engaging in a relationship that aims to share improved outcomes and benefits" (Soosay & Hyland, 2015, p. 613). Simpatung and Sridharan define supply chain collaboration as "two or more chain members working together to create a competitive advantage through sharing information, making joint decisions and sharing benefits which result from greater profitability of satisfying end customer needs than acting alone" (Simatupang & Sridharan, 2002, p. 19).

While a substantial amount of studies have been done about SC collaboration from a dyadic perspective the literature about multi-tier supply chain collaboration remains scarce. But the authors stress the importance of multi-tier supply chain collaboration to achieve flexibility, responsiveness, and shorter lead times in modern supply chains. Those factors influence the competitive position of a SC which ultimately affects all actors (Soosay & Hyland, 2015, p. 621).

These findings also highlight the importance of obtaining SC visibility which is a necessary prerequisite to adopt a multi-tier supply chain collaboration approach (Carter et al., 2015, p. 90; Sauer & Seuring, 2019, p. 32). However, moving from a dyadic perspective towards a multi-tier perspective is complex. Several barriers and challenges that are hindering multi-tier supplier collaboration can be identified and will be considered later on (Kembro et al., 2017, pp. 77-78) (Wang-Mlynek & Foerstl, 2020, pp. 465-466). First, the main benefits of multi-tier supply chain collaboration will be introduced.

### *2.2.2 Sustainability and chain efficiency as benefits of multi-tier SC collaboration*

Many authors are recognizing the strategic importance of multi-tier SC collaboration to achieve sustainability in supply chains. It is widely recognized that sustainability cannot be achieved by a firm solely, it requires the involvement of other SC actors (Soosay & Hyland, 2015, p. 621). Ramanathan et al. (2014, p. 235) introduce three different types of SC collaboration to improve sustainability. The first level is preparatory. This level involves the establishment of green policies for the supply chain. At this level, the policies and strategies should be exchanged with SC partners. The second level that the authors introduce is the progressive level of SC collaboration. At this level, companies have already implemented some of the established policies and are aiming towards long-term sustainability objectives together with SC partners. It also involves the regular sharing of information on ongoing implementation and policy changes. The final level of collaboration that they introduce is called the futuristic level of SC collaboration. This level involves the continuous support of SC partners for the reduction of carbon within the chain. It also involves a daily exchange of information across tiers. This framework can be used by companies to develop strategies to realise sustainability benefits through multi-tier SC collaboration and shows the importance of collaboration (Ramanathan et al., 2014, pp. 235-237).

Other authors also stress the importance of multi-tier SC collaboration to achieve green benefits (Gunasekaran et al., 2015, p. 2; M. Wilhelm et al., 2016, p. 209). However, they both also acknowledge that it is a complex task to involve sub-tier suppliers. Gunasekaran et al. (2015, p. 2), argue that it is difficult for focal companies to share green benefits gained by SC collaboration with (sub)suppliers. A selection of benefits includes; increase in corporate image, increased market performance, increased financial performance, and reduced SC costs. Companies are struggling to find a way to share these

benefits with other SC members. M. Wilhelm et al. (2016, pp. 196-197) add on this that it can be difficult to involve sub-suppliers in sustainability initiatives because of the lack of contractual relationships between the focal company and its sub-tier suppliers. Also the lack of visibility over sub-tier suppliers plays an important role. However, we already identified SC visibility as a prerequisite for SC collaboration.

Another benefit is related to SC efficiency. As orders move up the supply chain there is an amplification of demand variability. This effect is well known as the "bullwhip effect". This means that partners upstream of the SC are not able to forecast demand accurately and are unable to make optimal decisions. Ultimately, this will decrease the efficiency of the entire SC because actors are not optimizing capacity and are carrying excessive inventories (J. Q. Li et al., 2006, p. 264) (Kembro & Selviaridis, 2015, p. 465).

A solution to this problem could be to share information across multiple tiers. This can result in well-informed decisions by the SC actors involved (Yu et al., 2010, pp. 2986-2987) . The authors note that demand/capacity information sharing across tiers could result in a reduction of: inventory holding costs, shortage costs, and order cycle times. Kembro and Selviaridis (2015, p. 465) add on the concept of multi-tier information sharing. They argue that information sharing can occur at three different organizational levels. On the operational level, it involves sharing of order information, demand or sales data to facilitate orders and reduce information variability and inventory levels. On the tactical level, SC actors can share quarterly forecasts and expected future trends. This can enable resource planning and helps SC actors to allocate capacity and again reduce inventories. Finally, the strategic level. Information sharing on this level involves sharing of one-year sales forecasts and marketing strategies. This enables relevant upstream SC actors to plan effectively based on that information. Ultimately, sharing this information can increase the efficiency of the entire SC. Among the benefits are lower operating costs, higher productivity, and improved planning for all SC actors involved (Kembro & Selviaridis, 2015, pp. 465-466; Klein & Rai, 2009, pp. 737-738). New technologies have been developed to enable information sharing such as collaborative planning, forecasting, and replenishment (CPFR). Those technologies are all based on joint efforts by buyers and (sub)suppliers (Soosay & Hyland, 2015, p. 621). This makes multi-tier SC collaboration important to achieve those benefits. However, starting such collaboration initiatives remain a difficult task.

## 2.3 Antecedents of sub-tier supplier involvement

As already said, starting SC collaboration initiatives is not easy. Several barriers towards information sharing in a dyadic context have been identified. One barrier is related to the sharing of confidential information (Kembro & Selviaridis, 2015, p. 457). Supply chain actors might be reluctant to share confidential information because of the fear of opportunistic behavior of the information receiver. Those partners could exploit the information to benefit from it. Also, in a buyer-supplier context, there is the fear of passing out the first-tier supplier and sourcing directly from a second-tier supplier. These issues can negatively impact a firm's willingness to share information (Patnayakuni et al., 2006, p. 16) (Klein & Rai, 2009, p. 741). Another barrier is related to the lack of information quality. Information quality is determined by several factors such as reliability, timeliness, and accuracy. When information quality is lacking it has little value for the receiving partner. In other words, SC actors should recognize the shared information as useful, and a shared vision that the information will help the SC to succeed should be present (Fawcett et al., 2007, p. 360; Kembro & Selviaridis, 2015, p. 470).

However, the previously described barriers are based on the traditional buyer-supplier dyad. Several authors emphasize that some of these barriers are particularly difficult in a multi-tier information-sharing context. Also, new challenges can be expected compared to a dyadic context (Angulo et al., 2004, pp. 101-102). Kembro et al. (2017, p. 80) introduced a framework to categorize barriers and challenges towards information sharing in a multi-tier context. Their framework is based on a Delphi study which was done among a panel of SCM executives from various multinationals, as well as SCM experts from the consulting branch and academic SCM experts to provide an outside perspective. The authors identified 22 factors and grouped those into 6 categories that represent antecedents to multi-tier information sharing. These six categories are: technology utilization. Information utilization, cultural aspects, legal aspects, power structure, and business process aspects. Each category of their framework will be considered in the following sections.

### *2.3.1 Technology utilization*

Kembro et al. (2017, pp. 81-82) Introduced this category which consists of five factors: implementation costs, linked IT-systems, IT maturity, standardized terminology, and standardized formats for data exchange. In essence, this refers to the means for sharing and receiving data between SC actors. They argue that while it is technically possible to share data across multi SC tiers, in practice it is difficult due to the exponentially rising complexity within supply chain networks. They also note that often suppliers have multiple customers, which means that getting involved for them on different information-sharing platforms can be costly quickly. That means that factors such as low implementation costs are important for (sub-tier) suppliers to get involved in information sharing (Harland et al., 2007, p. 1236).

### *2.3.2 Information utilization*

This category includes three different factors: forecasting ability, planning competence, and information quality. It represents the question of how useful is the information being shared? If the information sender has a lack of forecasting ability and planning competence, the information will become of low quality. Low information quality also includes a lack of timeliness and misinterpretation of the shared information by the receiver (Forslund & Jonsson, 2007, p. 93; Kembro & Selviaridis, 2015, pp. 465-466; Klein & Rai, 2009, pp. 737-738). Delayed information can be damaging for upstream SC actors because they will base decision-making on old dated information. Knowing that consequences of wrong demand/capacity decisions are magnified when you move further up supplier tiers, this is an important issue (Kembro et al., 2017, p. 81; J. Q. Li et al., 2006, p. 264).

### *2.3.3 Cultural aspects*

For this category three factors are identified which are: trust, good inter-firm relationships, and cultural differences. The authors argue that culture in this context represents the willingness of SC actors towards collaboration and sharing information across tier levels. Lack of trust and good inter-firm relationships are associated with opportunistic behavior which is harmful to multi-tier information sharing (Porterfield et al., 2010, pp. 437-438). Cultural differences also give rise to difficulties in establishing good and stable relationships. A lack of good relationships contributes to a decrease in willingness to share information (Kembro et al., 2017, p. 82).

### 2.3.4 *Legal aspects*

The authors have identified three factors for this category: legal framework, confidential information, and intellectual property rights. Because suppliers and customers are usually active in multiple supply chains, shared information can travel horizontally, as well as vertically. Because the number of SC actors in a multi-tier context is high, it becomes difficult to control what information is shared with whom. This gives rise to confidential information issues. Companies can be fearful about their confidential information spreading across multiple tiers. Risks can be high and the authors indicate that some companies even perceive the risks to be higher than the benefits. Leaked confidential information could harm a firm's future position in negotiations (L. Li & Zhang, 2008, pp. 1468-1469). Companies can also be fearful of accidentally leaking others' confidential information. It can result in them being perceived as less trustworthy. The authors add that there is a need to establish a legal framework. But this difficult because of the high amount of actors that have to agree together (Kembro et al., 2017, p. 82).

### 2.3.5 *Power structure*

For this category three factors have been identified: dominant player able to initiate change, power asymmetry, and dependencies between firms. They argue that the power structure refers to the inter-dependencies between firms and their ability to influence others. Companies could be fearful to share information because of the risks of unbalanced dependencies between firms. They might be feared to get too "caught up" in information-sharing agreements. It could result in them losing power which reduces their competitiveness (S. Li & Lin, 2006, p. 1642). This could especially be present in a context where there are multiple powerful players present in the supply chain. If the SC consists of only one powerful player, it might be easier to implement multi-tier information sharing. The dominant player could start collaboration initiatives and set standards for data sharing. When multiple powerful actors are involved in a SC chain, this can become more difficult (Kembro et al., 2017, p. 82).

### 2.3.6 *Business process aspects*

The authors propose this category which consists of five factors: benefit and risk-sharing models, common goals, common performance measures, and linked business processes. They stress that it is important to link business processes so that there is a common purpose and all SC actors are working towards a common goal. An automated standardized solution should be in place to place orders and handle invoices to link more than two tiers. They note that when aiming for multi-tier information sharing it is not efficient and effective anymore to manually link business processes. Also, they argue that sharing risks and benefits is key. "Give and take" works well in a dyadic context, but is difficult in a multi-tier context due to amount of actors involved (Funda & Robinson, 2005, p. 588).

Kembro et al. (2017, p. 82) add, "far from everyone realize the benefits involved with increased information sharing, and just because the supply chain as a whole has improved, few of the partners actually see any gains on their own". This quote highlights the importance of benefit sharing in order to stimulate sub-tier supplier involvement. If (sub-tier)suppliers get the idea that they are not winning from information sharing, and only the focal company is benefiting, this very likely to reduce their willingness to share information (Ballou et al., 2000, p. 17). Kembro et al. (2017, p. 82) also argue that risk sharing is important. When multi-tier capacity and demand sharing systems are in place, mistakes and incorrect forecasts will occur. This could result in incorrect planning decisions of upstream suppliers, which could ultimately result in extra costs. Costs can be in the form of excessive inventory, tied-up capital, or lost sales. In a multi-tier context, these issues are more problematic and could reduce the willingness of SC actors to share information.

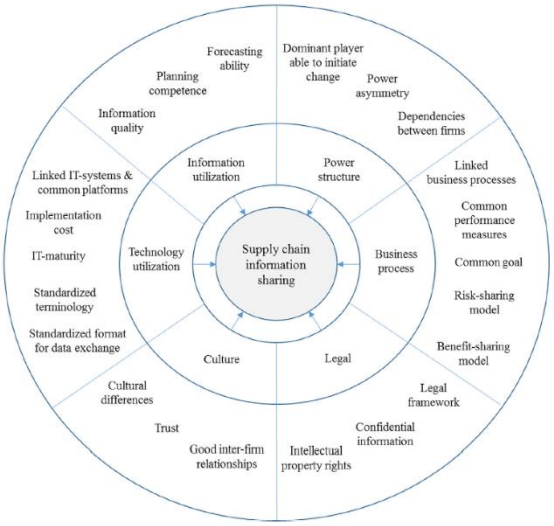


**Figure 1: Antecedents of multi-tier information sharing (Kembro et al., 2017, p. 81**

## 3. PROPOSITION OF A RESEARCH MODEL TO IDENTIFY BARRIERS TOWARD MULTI-TIER INFORMATION SHARING AND STRATEGIES TO STIMULATE SUB-TIER SUPPLIER INVOLVEMENT

Thus it can be assumed that other barriers and challenges are present when talking about SC collaboration in a multi-tier context compared to the common dyadic perspective. However, yet few research has been done to determine the importance of different barriers and challenges for suppliers. Also, little research has been done about methods to overcome the issues concerning multi-tier information sharing. Those outcomes could be used to develop optimal implementation strategies for multi-tier information-sharing initiatives.

The framework developed by Kembro et al. (2017, p. 81) will act as a basis for our research model. However, some factors will be grouped to simplify the model. This is needed to reduce the scope of the research because our research also considers ideas to overcome those barriers and stimulate sub-tier supplier involvement. Because some of the factors in the model already show some redundancies, we are able to group some of the factors inside categories together. In figure 2 we present our research model. All categories are expected to be perceived as major barriers or challenges for sub-tier suppliers towards multi-tier information sharing. However, power structure factors are expected to be perceived as of less importance due to the nature of the automotive industry, where lower-tier suppliers generally have less power than downstream SC actors. The importance of factors is indicated with a +/-. This research model, which explains the antecedents of multi-tier information sharing, will test which categories are perceived as barriers by sub-tier suppliers towards information sharing in the automotive industry.

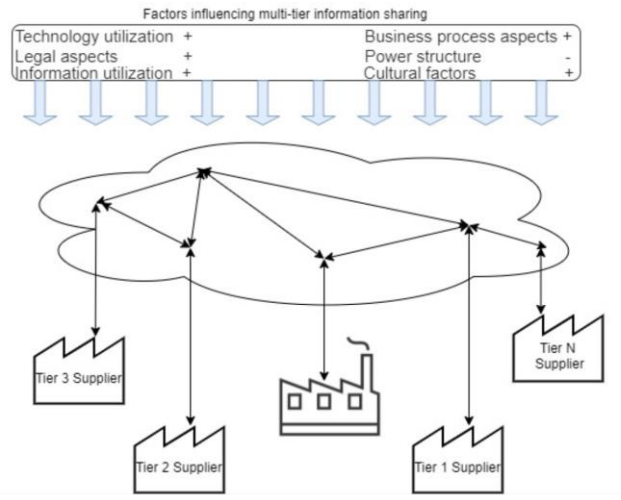


**Figure 2: Potential factors influencing multi-tier information sharing**

The research will consist of two exploratory parts. The first part where the barriers and challenges will be identified, and the second part where potential ways to overcome the identified barriers will be considered. If we recall our previously defined RQ 1.1: *What are barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing?* We can introduce several hypotheses based on assumptions made in the reviewed literature.

*H1: Technology utilization factors are seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

*H2: Legal aspects are seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

*H3: Information utilization factors are seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

*H4: Business process aspects are seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

*H5: Power structure aspects are not seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

H6: Cultural factors *are seen as major barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.*

The second research question that will be considered is RQ 1.2: *What are the methods to overcome those barriers and successfully involve sub-tier suppliers in information sharing initiatives?* The different categories in our research model will act as guidance for the development of sub-tier supplier information sharing stimulation strategies. In the following section, the methodology will be discussed.

# 4. METHODOLOGY: QUALITATIVE DATA COLLECTION

For this research, a qualitative method has been chosen. Qualitative research is seen as an important way of data collection for the field of business. It has been able to make a central contribution to theory building in management. Qualitative methods can contribute to theory development in several ways. They are able to provide thorough descriptions of real phenomena and stimulate deeper thought. But, they also allow for stronger conceptualization and it provides a safeguard against heuristics. Also, because theory is shaped progressively it enables the researcher to constantly compare data to existing literature and create new theoretical insights (Doz, 2011, pp. 583-584). But, due to a small sample size, findings of this qualitative research can not be generalized (Rahman, 2016, p. 105).

A focus group in the form of supplier sounding board sessions was considered for this research. The focus group is a technique of information gathering based on a discussion among a group of people. It is particularly helpful to analyze phenomena and pointing out unexpected aspects, as well as different insights. However, participants could feel less comfortable with sharing their own opinion when it is contradictive to the opinion of the rest of the group. This can be due to the concern of social disapproval. Another limitation is related to confidential information. Participants might be less willing to share their views due to confidentiality reasons (Acocella, 2012, pp. 1126, 1131-1134). Also, due to the COVID-19 situation the supplier sounding board sessions were postponed. These limitations made it not suitable for our research.

The chosen technique for data collection is expert interviews. Interviews have the purpose of gathering descriptions of the life-world of the interviewee with respect to the interpretation of the described theories. Due to COVID-19 and geographic distance, some of the interviews were conducted via a video call others were in person. Video interviews have the advantage that you have a wide geographical access. However, a disadvantage is that there are fewer possibilities to create a good interview ambience (Opdenakker, 2006, pp. 1-2, 6). The interviews were semi-structured based on a key set of questions developed among the factors described in the research model. Semi-structured interviews have the advantage that it allows the researcher to come up with follow-up questions if things are unclear. Also, it allows space for verbal expressions of the participant. A limitation could be that semi-structured interviews require knowledge about topics by the interviewer (Kallio et al., 2016, p. 2955). But in this research that is not an issue due to an extensive literature review. Another drawback could be that semi-structured interviews can be time-consuming and biased. Participants could be biased in their answers because they are trying to portray themselves in a better way (Boyce et al., 2006, pp. 3-4).

The aim of the expert interview was to compare their view of barriers and challenges of multi-information sharing towards the research and obtain insights on the importance of different factors. Also, methods to overcome the barriers and challenges were discussed. The questions were open-ended and have been communicated ahead of time along with a brief introduction of the interview to prepare the participants. Interviewees were also asked to reflect on the importance of these barriers in the automotive industry, as well as highlighting key differences between other sectors. Interviews were conducted in English, Dutch, and German, dependent on the native language of the respondent. Due to the language barrier with one German respondent, that interview was a shortened version conducted in a written format. The respondents have also been informed that the results of the interviews will be anonymized. This generally improves the willingness of people to participate in the interview (Saunders et al., 2015, p. 619).

In total seven experts had been selected for the interviews. But due to personal reasons, one expert cancelled. This left six experts participating in the research. Experts have been selected based on their experience in the field of global business and supply chain management. The composition of the experts group was diverse. It consisted of 3 SCM consultants and experts. Also

3 directors of multinational firms were part of the group. Two of them were active in the SC platform cloud services industry, whereas the other was active at global supplier of parts, technical service, and business solutions. The questions used in the interviews can be found in appendix B.

# 5. ANALYSIS AND RESULTS

## 5.1 Experts introduction

Detailed description left out due to confidentiality. But as already mentioned, interviews were conducted with experts in the field of global supply chain management. Several of them had experience with multi-tier information sharing. Expert have been named (X1,X2…., X6) Detailed transcripts of the interviews can be found in appendix C.

## 5.2 Findings

### *5.2.1 An increasing need for multi-tier supply chain management*

The experts indicated that there is an increasing need for multi-tier SCM. X1 points out that the market is getting increasingly transparent. This transparency also requires focal companies to go deeper into the N-tier levels of their supply chain. "As an actor in the supply chain, you can only survive if you are offering a real-added value. If you are unable to provide this added value, or you are unable to find a way to provide value. Eventually, you will get pushed out of the market". In his view, this essential transparency, which is needed to survive, will require the transmission of as accurate information as possible by all SC actors. This requires organizations to go beyond their direct-tiers, and move into multi-tier SC management.

But, also the events of this year have played an important role in the rising need for multi-tier SCM. The COVID-19 pandemic, as well as the blockage of the Suez canal, has brought issues to the forefront. As X2 highlights, on January 2020, "almost everyone had realized they had a sub-tier supplier located in Wuhan. Which until then, they had never seen before." If that sub-supplier was your single source, this certainly harmed your supply assurance. X5 supports this and indicates that the pandemic has caused more uncertainty in the supply chain. The uncertainty leads to an increasing need for information about N-tier suppliers.

In other words, the experts indicate that risk and resilience have gotten increasingly important. As X2 indicates, "there is not only an increasing need for multi-tier information sharing but also an increasing desire". The question of whether a company has identified the points of failure in their SC is increasingly asked by stakeholders. In order to answer those questions, SC visibility and multi-tier information sharing are needed. The described events also showed focal companies that their often-rock-hard contracts with first-tier suppliers, do not always work. If the container with parts for their tier-1 supplier is on the stranded ship in the Suez Canal, parts will not be delivered. "The result could be that harsh penalties are being paid by the tier-1 supplier. However, the production line is still standing still". This example highlights the increasing need for multi-tier information-sharing initiatives.

X3 also emphasizes that the current situation in the automotive industry plays a role. Cars are getting more high-tech with screens and more complex built-in chips. That means that the automotive industry has top tap into the world of consumer electronics. At this point, the consumer electronics industry is not used to the automotive industry and its production cycles for example. It can be seen by the problems that are now occurring with the supply of semi-conductors. More visibility and information sharing are needed to detect risks and align production plans.

### *5.2.2 Barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing*

The findings of the conducted interviews considering the barriers and challenges from our research model will be considered in the following sections. They are grouped by the six identified categories with potential barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing.

#### *5.2.2.1 Technology utilization factors as a barrier towards sub-tier supplier involvement in multi-tier information sharing*

Technology utilization factors are seen as a barrier and challenge towards sub-tier supplier involvement. Especially implementation costs play an important role. The number of actors involved in multi-tier SC information sharing platforms rises exponentially when going deeper into the N-tiers. But at the same time, the size of SC actors decreases the further upstream you go. In other words, sub-tier suppliers are usually smaller in size. X1, X2, X3 and X5 indicate that a correlation between the size of a SC actor and the extent to which barriers from this category play a role can be expected. Bigger suppliers are usually working with ERP systems such as SAP or Oracle. These systems contain a standardized data format that can be linked by way of portals to provide input into a digital supply chain platform. However, because of high costs, it is more difficult for smaller suppliers to utilize ERP services. As X1 notes, "The more mature a SC actor is, the easier it is for him to get involved in multi-tier information sharing". X4 adds, "Bigger suppliers have more resources available, as long as they see the economic value of sharing information. The initial investment should not be a big problem". However, smaller (sub)suppliers might have fewer resources available. This often implies a smaller IT workforce which makes it more difficult for them to develop a connection for their internal systems with a digital supplier platform.

X2 emphasizes that technology utilization barriers are especially present within the automotive industry because of their centralized mindset. This mindset could cause problems considering a standardized format for data exchange. They might think that all suppliers will connect to their systems and deliver data formats based on their standards. However, "you have to realize that all of those suppliers are being asked the same by the other automotive manufacturers. The question is whether you are going to force another 100 thousand IT projects on those suppliers?" If you want to stimulate their involvement, this might not be the best way forward. X3 supports this idea and indicates that if suppliers have to manage too many standards, it will become too costly for them.

Also, IT maturity factors play a role. Again, the size of sub-tier suppliers is deemed important here. As the size of SC actors becomes smaller, usually their IT maturity decreases. When IT maturity is lower, more problems can be expected towards information sharing in general, but also multi-tier. There might be sub-tier suppliers who do not have reliable WMS systems in place. This will decrease the reliability of shared information, if that is even possible for them. X1, X2, and X4 indicate that they do not see standardized terminology factors as a barrier. Instead, it should be seen as a prerequisite of multi-tier information sharing. When standardized terms are not present, sharing data such as inventory levels is impossible. On the other hand, X3 argues that standardized terminology can be an issue. From his experience in a pilot, he has experienced that you have to decide

on questions such as what is a demand? What is a stock level? This terms differ across companies and need to be standardized to make it work for all SC actors.

#### *5.2.2.2 Legal aspects as a barrier towards sub-tier supplier involvement in multi-tier information sharing*

In multi-tier SC collaboration projects legal barriers do exist, and most actors that are involved, are also aware of them. However, they are solvable. Data security is seen as a concern by all actors involved, first-tier suppliers as well as sub-tiers. It is something that should be managed, but it should not be seen as a complex issue to solve. As indicated by X4, "It is not a barrier…. It as an easily solvable problem".

Also, the confidentiality of information is by most experts not expected to be a major barrier because of the characteristics of the information shared. The main aim of the digital supplier platform is to share demand and capacity data across tiers. By most actors, this information is not regarded as strictly confidential. Also, abuse of shared (semi)confidential information by actors in the SC is not expected to be a major issue. Markets are evolving fast, and for most components numerous sources are available. If one party abuses confidential information in price negotiations, chances are high that another supplier will be chosen. The risks of abuse of confidential information are perceived to be bigger than the potential benefits that can be earned. X4 has another view. He argues that "the BOM is the heart of your organization", and that it should not be published in the cloud due to the risks of data hacks. He notes that organizations with uncertainties about cloud security can be expected.

To avoid issues, a legal framework is deemed important. This is also where challenges can be expected. As X1 notes from his own experience: "As soon as corporate lawyers get involved, things can get complex." The multitude of companies active on a digital supplier platform can make the approval of a legal framework a time-consuming procedure.

#### *5.2.2.3 Information utilization factors not seen as a major barrier or challenge towards sub-tier supplier involvement in multi-tier information sharing*

In some industries, this category could be regarded as a major barrier towards sub-tier supplier involvement. However, not in the automotive industry. As X1 argues "Factors such as planning competence and forecasting ability are already prerequisites to successfully operate in the automotive sector". For decades, production plans have been changing rapidly. Changes in production plans of the OEM reflect in changes in demand for (sub-tier) suppliers. Because of the nature of the automotive industry, with its rapidly fluctuating demands, all successful actors have developed forecasting and planning mechanisms. Therefore, this barrier is not expected to be a major problem. X2, X3, and X5 support this idea. However, X3 adds that there might be problems with new battery suppliers for example. He notes that those suppliers are not so used to the frequent demand changes of the automotive industry yet, and seem to be less able to plan their production.

Also, the deeper down the N-tier levels you go, the bigger the problem gets due to a decrease in supplier size. But at the same time, there is also a decrease in value of the supplied product. That is also where planning competencies and forecasting abilities play less of a role. For example, when suppliers are selling commodities, planning does not matter that much anymore. If you are suddenly buying 10 tons more of a product sitting in silos, this is not an issue. X2 indicates, "the closer you come to the core, the higher the value of an individual unit". A higher value implies an increased importance for forecasting and planning competencies.

#### *5.2.2.4 Business process aspects as a barrier towards sub-tier supplier involvement in multi-tier information sharing*

Generally speaking, most firms in the automotive industry are very mature considering their business processes. But again, when moving further outside of the center, the maturity level of firms tends to drop. Especially starting around the 4$^{th}$ tier level, problems can be expected. As X2 indicates: "A substantial amount of Chinese sub-tier suppliers is running on a pirated version of Microsoft Excel. That is what they use as their ERP system." That means that their processes might also be immature, which could make it incompatible to link with a digital supplier platform in order to realise valuable information sharing.

Benefit-sharing is also perceived as a barrier. X1 emphasizes that "naturally the biggest player in the supply chain also reaps the biggest benefits of SC information sharing". Especially sustainability benefits are seen as difficult to share. However, it is also the responsibility of OEM's to start CSR practices for the SC chain, which makes it also justified that they reap the biggest part of those benefits. Nevertheless, benefits should be shared in a fair way to stimulate sub-tier supplier involvement. But the question remains, what is fair? "Something that might be fair for the focal company, could be perceived as totally unfair by a sub-tier supplier". The other experts also emphasize the importance of benefit sharing. X4 emphasizes that you need to create a "win-win situation based on the economic principle of balance". X5 argues along this line. He indicates that all involved parties need to benefit by sharing data. Accurate forecast data could be one of those benefits. It is deemed as highly valuable by (sub-tier) suppliers because they want to increase their delivery reliability. However, X3 argues that as an OEM, you can not ask for many different types of data, and only give forecasts in return. The amount of information shared should be leveled. Meaning, more information than just forecasts should be shared in return.

Risk-sharing should not be seen as a barrier because it is very implicit. Incorrect planning decisions at sub-tier suppliers, based on false information provided by a digital supply chain platform, will happen. But in practice, those risks are impossible to measure. Correlation does not imply causation, which makes it difficult for sub-tier suppliers to prove that particularly cost increases came from a specific factor related to the shared information. Rather, risks will automatically result in price increases at a supplier. In other words, potential risks will be implicitly shared through price changes. X1 and X5 also argue that risks will be reduced due to multi-tier information sharing. Therefore, there is no need to reduce risks.

Common goals, and common performance measures are not seen as a barrier or challenge because of the maturity of the automotive industry. X1 indicates "all SC actors are already aware of the common goals within the industry".

#### *5.2.2.5 Power structure aspects not seen as a major barrier or challenge towards sub-tier supplier involvement in multi-tier information sharing*

Power structure aspects are not regarded as a challenge in the automotive industry. However, in other industries such as the retail sector, this could be regarded as a major barrier. X1, X2, X5 indicate that the supply chains in the automotive sector are characterized by a power asymmetry. The OEM has high power,

and once you move further upstream the power of SC actors decreases. This leads to a situation where often sub-tier suppliers have very little power over their customers. X2 adds that there could be some tier-1 suppliers with substantial power compared to the OEM, but for sub-tiers, this is very rare. X1 also indicates, "the market is very agile, and suppliers know that. A powerful (sub-tier) supplier today, may not be a powerful player tomorrow".

This also means that suppliers are very cautious with exerting power. They do realise that if they abuse their power once, as soon as new suppliers are entering the market, they will be terminated. Furthermore, the assumption that there is an existing fear at (sub-tier)suppliers to lose their competitiveness once they get involved in multi-tier information sharing is maybe not right. X1 argues that their competitiveness will decrease if they are not getting involved in multi-tier information sharing. The suppliers that are getting actively involved could then become preferred.

#### *5.2.2.6 Cultural factors as a barrier towards sub-tier supplier involvement in multi-tier information sharing*

Cultural factors are regarded as an important barrier towards sub-tier supplier involvement in multi-tier information sharing. The factors in this category are expected to be especially present in the automotive industry. The reason is that in the past decades there has been a major cost-focus of automotive OEM's towards their suppliers. As X2 notes, "year after year cost reductions were demanded of first-tier suppliers". As a result, first-tier suppliers have greatly improved their processes. But first-tier suppliers have passed this pressure now down to their suppliers because they simply had to. Furthermore, strict penalties for late or not delivered products are usual in the industry. "It is a very coercive way of collaboration" that automotive OEM's have developed with their suppliers. Who in turn, have also passed this down to their supplier base. X5 supports this idea, he notes that due to high competitivity in the automotive industry, there can be a lack of trust.

Now the OEM has to approach the same first- and sub-tier suppliers to ask whether they want to share capacity and demand information. Their first reaction will probably be along the lines of "Why do they want this? Every time I have given them information in the past, they have used it against me". This example highlights that trust can be expected to be an issue. The model needs to be transformed from "coercive to collaborative". X3, X4, and X5 also emphasize the importance of building a collaborative relationship with your (sub-tier)suppliers. X3 indicates that it is hard to build trust, and it is like a "building that can collapse really fast". X5 adds that also the culture of the industry can play a role. From his experience, some industries, such as transport, are very reserved with information-sharing. In these industries, it is especially difficult to implement multi-tier information-sharing initiatives.

Also cultural differences can be regarded as a challenge. X1 recalled a famous quote which is "culture eats strategy for breakfast". In other words, even if there is a strong strategic plan to start a digital supply chain platform. Implementation could be held back by cultural differences between SC actors. X3, X4 and X5 also indicate that the willingness of organizations to share information differs among continents. West-Europe is regarded to be fairly cautious with security and sharing information on the cloud. On the other hand, the US can be seen as a front-runner who likes new things. Asia is regarded to be fairly opportunity-driven. In other words, if the customer asks they are generally willing information. However, in the end everyone understands the need for transparency and the related benefits of sharing capacity and demand data. Therefore, cultural differences should be regarded as a short-term barrier, in the form of a communication challenge.

All interviewees were asked to rate the 6 categories with potential barriers on a scale from 0-4. Where 0 is non-important and 4 is very important. The results are summarized in Fig. 3. In appendix D, a detailed description including mean scores can be found.

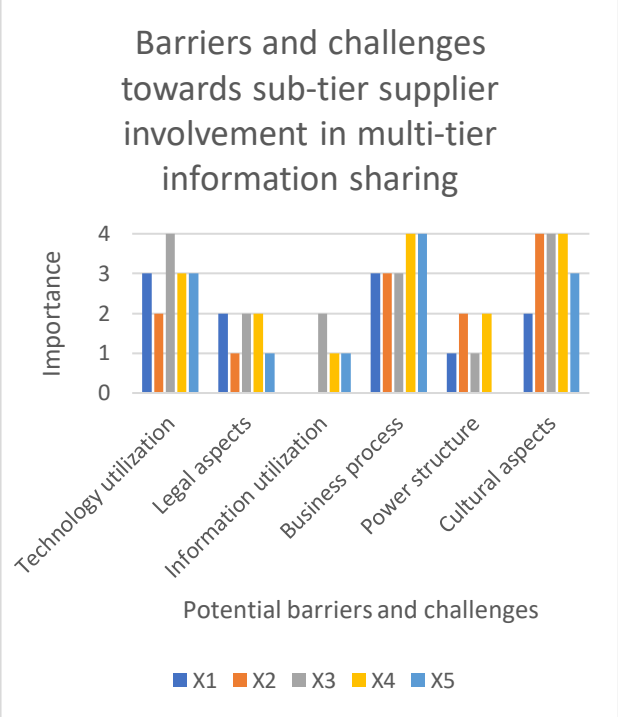


**Figure 3: Importance of barriers and challenges towards sub-tier supplier involvement**

Cultural factors and business process aspects are seen as very important by the experts. Technology utilization factors are seen as moderately important, followed by legal aspects. Power structure aspects are seen as slightly important. Information utilization factors are not seen as important by the experts.

### *5.2.3 Other barriers towards sub-tier supplier involvement in multi-tier information sharing*

X2 proposed the introduction of another barrier that can be foreseen when trying to involve sub-tier suppliers in multi-tier information sharing. It is a regulatory barrier. Whereas on the one hand regulation is driving multi-tier SC collaboration, in some countries it can also be regarded as a barrier. The expert mentions several cases from his past work experience where they were not allowed to implement various information-sharing systems because of political issues. Especially in strict countries such as China, or within heavily regulated industries, there can be rules on which persons can work on data provided by a particular company. "It is the arising issue of the geopolitics of cybersecurity".

X3 introduces the existence of a dominant solution as a barrier. In other words, once a dominant SC platform has been developed it will be very difficult for other providers to start a new platform and also get suppliers on board. It is key to be one of the first in your industry.

### *5.2.4 Strategies and methods to overcome the identified barriers towards sub-tier supplier involvement in multi-tier information sharing*

The interviewees have also been asked about their experience regarding methods and strategies to overcome the barriers we

have identified in the previous section. These findings will be discussed in the following sub-sections.

#### *5.2.4.1 Flexibility in supporting data inputs as a method to overcome technology utilization barriers*

The dynamics of networks pose difficulties considering technology utilization factors. As indicated, these are especially present in the automotive industry. The OEM's are often still used to a centralized model. X2: "They might think of themselves as the center of the universe". In other words, if they think about multi-tier SC information sharing, they think that everyone will connect to them. It might sound logical to think of standardization of data requirements as the solution. However, the required standardization of data formats could lead to the need for massive IT investments at (sub-tier) suppliers, who have to rearrange their systems in order to comply with the required data format. As X2 indicates, "A guy says, we have got 59 incompatible standards. So I am going to make a new one which will replace all of them. The result now is that we have got 60 incompatible standards".

While the quote was said as a joke, it contains a core of truth. Standardization of the format of data inputs might not be the solution to stimulate sub-tier supplier involvement because it requires thorough IT investments from their side. The solution lays in flexibility. Meaning that a developed supplier platform is able to support different inputs of data. It should be able to support input from commonly used systems such as Oracle, and SAP. But also other message formats, such as simple excel files with inventory which could come from lower-tier suppliers with less IT maturity. Information sharing for sub-tier suppliers should be made as easy as possible to stimulate their involvement. X5 supports this idea, he adds that technology should be made as accessible as possible. This can be achieved by developing data portals for different ERP systems and supporting a wide range of data inputs.

#### *5.2.4.2 Management of data security as a method to overcome legal barriers*

Especially concerns about data security and the adoption of a legal framework can be seen as a barrier towards sub-tier supplier involvement in multi-tier information sharing. X4 indicated that data security should be regarded as a top priority during the development of a digital supplier platform. Data encryption could be a solution to enhance data security because it provides a safeguard against the hacking of data. X3 argues that a way for SC actors to decide who can view their data such as inventory levels should be developed. This provides more security considering who can view what. "SC actors should be fully in control of their data". This also means that when you delete something on the platform, it has to be completely gone.

Furthermore, the development of a clear legal framework is important which should address the main issues of data sharing in a multi-tier context. Because probably all SC actors have to agree on a legal framework, this can be a time-consuming procedure. It should address the main issues. For example; what information can be shared, how is information stored/secured, how can information be used for decision making and who owns the shared data?

#### *5.2.4.3 The development of a communication strategy to overcome business process barriers and cultural barriers*

Benefit-sharing and trust are both regarded as potential barriers towards sub-tier supplier involvement in multi-tier information sharing. However, benefits for sub-tier suppliers of sharing capacity and demand data are certainly there. Heavily fluctuating demands which are passing and amplifying through multiple tiers is a characteristic of the automotive industry. At the moment, one of the main problems is that N-tier suppliers receive these demand changes too late, which leaves them with little room to adjust their production planning. This leads to inefficient business processes and increased stocks. Increased stock levels lead to increased costs such as holding costs.

If you compare the current situation with the proposed one. In the proposed situation, those demand changes will receive sub-tier suppliers much faster. This gives them a time advantage to adjust their production plannings according to the new forecasts. This should lead to immediate bottom-line benefits. However, it is still regarded as a barrier.

This is partly due to the nature of relationships between SC actors in the automotive industry. As X2 indicated, for years cost reductions have been required and harsh penalties for suppliers are in place. This has led to a coercive SCM model which also results in little trust between SC actors.

The issue can be overcome by approaching the project of a digital supplier platform differently. X2: "Most companies tend to see these things as an IT project". And they tend to communicate it like that to their suppliers. "But actually IT is the last thing. IT is just an enabler". These projects should be regarded as multi-tier collaboration projects where the relationship with suppliers is central. OEM's should start with explaining what is wrong, and recognizing the problems that they are causing at (sub-tier)suppliers by constantly rush ordering and de-committing which is leading to inefficient planning at suppliers. The OEM's now need to go to their (sub-tier)suppliers and ask if they would like to share inventory data. As a first reaction, they will probably not be eager to share their information.

To stimulate their involvement, a communication strategy about the new project should be developed which explains to suppliers how the current situation will improve and cause positive value for them. Because in the end, if the OEM shares forecasts with suppliers, they are able to plan their inventory better which results in direct bottom-line improvements. "Communication is key." As an OEM it is important to put yourself in the position of your suppliers and think of your behaviours that are causing negative value for them. On that note, a communication strategy should then contain an explanation of how this behaviour can be changed if the supplier gets involved in multi-tier information sharing. X4 also stresses that communication is important. It should be seen as a collaboration project where there is an economic balance between SC actors. In the implementation of such projects, "humanity should always come first". Moreover, X5 argues that you should communicate the strategic necessity to your sub-tier suppliers. Often they are not aware of this.

#### *5.2.4.4 Technology roll-out strategy to overcome cultural barriers*

Because trust between SC actors is seen as a challenge, a technology roll-out strategy should be developed. X1 argues that it could be an idea to first implement a digital supplier platform with strategic partners where the relationship is good. Also, the supply chain of a particular strategic component or material could be chosen, for example, the supply of cobalt which is regarded as vulnerable to human rights violations. Most SC actors involved then have a common understanding and a common goal on why information should be shared.

Starting with strategic partners has the advantage that they are likely to be more willing to share information. Especially in the early phases of the platform, it is important that suppliers are willing to collaborate and provide feedback to improve the platform. Uses cases could be developed with those suppliers,

which could ultimately convince other sub-tier actors to get involved.

#### *5.2.4.5 Other methods and strategies to overcome barriers towards sub-tier supplier involvement in multi-tier information sharing*

To overcome benefit-sharing challenges, X1 advises a thorough calculation of expected benefits by the OEM. This should contain a description of the expected decrease in supply chain disruptions costs caused. Also, increased customer value when N-tier supply chain transparency is provided should be regarded. But also development costs and costs for technology roll-out should be regarded. The estimated cost-savings for the OEM could act as a starting point for benefit-sharing practices. The estimation can give insights on whether benefits can be expected to be shared equally when suppliers are benefiting from better demand forecasts or other benefit-sharing mechanisms should be considered. X4 adds on this that you should always put humanity first. If you consider your business relationships as valuable people, it helps to develop ways for equal benefit sharing.

Another way to stimulate the involvement of sub-tier suppliers could be the introduction of sub-tier supplier certificates for suppliers who are involved on the digital supplier platform. X1: "for sub-tier suppliers, it could be beneficial to be able to show that they are delivering parts to a well-known automotive manufacturer". Sub-tier supplier certificates, handed out by the OEM could increase the competitiveness of a sub-tier supplier. X3 supports this idea. He adds that those certificates could help sub-tier suppliers to show they meet certain standards which are maybe valued by other OEM's.

# 6. DISCUSSION

## 6.1 Confirmation of the increasing need for multi-tier information sharing

The experts indicated that there is an increasing need for multi-tier information sharing. It was argued that events of the past year have brought N-tier supply chain transparency issues to the forefront. This is in line with findings from academic literature (Chowdhury et al., 2021, p. 2; Wang-Mlynek & Foerstl, 2020, p. 465). They have also highlighted the relationship between the COVID-19 pandemic, supply chain disruptions, and the need for N-tier supply chain transparency. Also, stakeholder management was introduced as a driver for multi-tier information sharing by an expert. It was mentioned that internal stakeholders, as well as customers, are demanding supply chain transparency. Board members are concerned about risk and resilience and want to know where their weaknesses are located in the SC. On the other hand, customers are increasingly requiring transparency because they want to know where their products are coming from. This is in line with findings from Dou et al. (2018, p. 9), who indicated that the increasing pressure from customers is requiring firms to beyond organizational barriers and focus on multi-tier SC management. It is also in line with findings from Sodhi and Tang (2019, p. 2949), who argued that multi-tier SC management is needed because it creates SC visibility which enables companies to develop prevention strategies against SC disruptions and mitigation strategies to reduce negative impacts. There could be argued that this falls under stakeholder management. The results are also in line with academic literature from Nooraie and Parast (2015, pp. 198-199), who concluded that multi-tier SC management is needed to manage risks and costs involved in the SC.

Regulatory drivers were not mentioned by the experts as a factor that is affecting the need for multi-tier information sharing. This is not in line with different findings in the literature that identified the recent introduction of SC due diligence regulation as a driver of multi-tier SC management (Smit et al., 2020, pp. 6-7; Zamfir, 2020, p. 2). However, the main aim of the interviews was to discuss barriers and challenges. This also means that drivers of multi-tier information sharing have not been discussed in depth. Based on the literature. we can still assume that the introduction of SC regulation is regarded as an important driver of multi-tier SC management and information sharing.

## 6.2 Barriers and challenges towards sub-tier supplier involvement

This research builds on the work already done by Kembro et al. (2017). They have identified 22 factors which pose potential challenges and barrier to information sharing beyond dyadic relationships. The research model is based on their model of antecedents, and it aimed at finding out which of the barriers are expected to be present within the automotive industry. It also aims to fill the gap raised by Sauer and Seuring (2019, pp. 40-41), who called for more research in an industry-specific context considering multi-tier SCM.

The results from X6 are excluded from this research. Because of the language barrier, questions were handled via email. However, judging from the provided answers there seems to be a misunderstanding at X6 about the categories of the research model. For example, factors as trust are named at the power structure category. Because the interview was not conducted in person, the reliability and validity of the answers can not be guaranteed. Therefore, the results from X6 are excluded from the research.

Looking at how the experts have rated the potential barriers and challenges towards sub-tier supplier involvement in multi-tier information sharing, we are able to draw some (limited) conclusions. The importance of barriers and challenges has been rated rather similarly among the five experts. There are only three categories with each one case of a two-point difference between ratings (technology utilization, information utilization and cultural aspects). It could be explained by the way that the experts took account for all factors inside the category. The cultural aspect consists of three factors which are cultural differences, good inter-firm relationships, and trust. The latter two were perceived as highly important by the interviewees. However, cultural differences were mentioned to be short-term issues that are not difficult to overcome. One expert likely balanced his importance rating based on all of the factors inside the cultural aspects category. Whereas the other expert based his rating solely on the factors trust and good inter-firm relationships. It should also be mentioned that the ratings are based on a small sample size. Therefore, conclusions can only be drawn with uncertainty and should not be generalized.

Based on the ratings, technology utilization, business process factors, and cultural factors are seen as major barriers for multi-tier information sharing in the automotive industry. These findings are confirming the findings of Kembro et al. (2017, p. 83).

Legal and power structure factors are perceived as minor challenges within the automotive industry. This is not supporting the findings of Kembro et al. (2017, p. 83). In their research, both categories were expected to represent a medium/major challenge. This can be partly explained due to the characteristics of the automotive industry, which was the context of this research. The automotive industry is known for its SC structure where the OEM has a very substantial amount of power. In addition to that, power is decreasing once you move further through the tier levels. That leads to a situation where sub-tier suppliers can not be feared of losing their power position compared to the OEM because in most cases, this power is not existing. Legal barriers

are also perceived as a minor challenge, whereas Kembro et al. (2017, p. 83) regarded this as a major challenge. This could be explained by also considering the nature of the information shared on a digital supplier platform in the automotive industry. The main aim is to share long-term forecasts and capacity and demand data. This means that suppliers are expected to share data such as inventory levels. During the interviews, it was mentioned that this data is often not seen as highly confidential. Therefore, legal challenges concerning confidential information are perceived as a minor challenge in this research. This could be different when other types of shared information are considered or in other industry contexts.

Information utilization factors are not seen by the experts as a barrier within the automotive industry. This is not in line with findings from Kembro et al. (2017, p. 83). They regarded information utilization factors as a medium to a major challenge. A possible explanation can be found by taking the characteristics of the automotive industry into account. For decades, the demands of OEM's have been fluctuating frequently. These unreliable production forecasts have led to a need for (sub-tier) suppliers to develop their planning competences and forecast abilities. These two factors have turned into prerequisites to be successfully active within the industry. Therefore, the industry is so mature that information utilization factors are not perceived as a barrier anymore. As also X2 and X5 indicated, the importance of this barrier is heavily depending on the industry context and type of supplier.

Based on these findings, an implication for theory is that potential barriers and challenges for multi-tier information can be expected to differ greatly across industries. Each industry has its own characteristics which influence the importance of barriers and challenges. Practically, the findings on the importance e of different barriers can be used by organizations to guide their next steps when they want to start multi-tier information sharing initiatives. It provides input on where to put priorities.

## 6.3 Methods and strategies to overcome the barriers

Because methods and strategies to overcome the identified barriers have also been considered, this research can provide automotive firms some guidance to deal with multiple factors to enable multi-tier information sharing. The findings in this research partly fill the gap highlighted by Kembro et al. (2017, p. 84), who introduced in-depth case studies as a future research opportunity in the field. The case studies could be useful to understand how companies can overcome the barriers and challenges when moving beyond dyads. While this research is not an in-depth case study, it provides some practical guidance for automotive firms on methods to overcome the challenges based on the past experiences of experts.

The development of a communication strategy that highlights benefits for sub-tier suppliers has been introduced as a method to overcome trust and benefit-sharing barriers. If a new platform with the requirement of shared inventory data is communicated correctly, this is likely to increase the willingness of SC actors to get involved. It is key that they realise how they are winning from involvement. This is in line with findings from Harland et al. (2007, p. 1245), who emphasize that suppliers are often not aware of the benefits of information sharing. Also, flexibility in supporting data inputs has been proposed as a method to overcome technology utilization barriers. It should be mentioned that the views of the experts were contradicting here. Two experts mentioned that data standardization is important, in order to make it as easy as possible for SC actors to connect. However, X2 and X5 viewed this differently. They argued that requiring data standardization will not result in an increase in sub-tier supplier involvement. If they have to adhere to new data standards, they might have to change their IT systems which can be a costly procedure. Rather, the digital supplier platform should be able to support data inputs from different systems. This involves ERP systems such as SAP and Oracle, but also smaller and less commonly used systems should be supported on the platform. Flexibility in supporting data inputs is expected to reduce implementation costs for sub-tier suppliers, and therefore increase their willingness to get involved.

Also, a technology roll-out strategy is proposed where some key SC actors are prioritized. A selection of suppliers could be based on those where the relationship is collaborative. They might be more willing to try a new platform and provide feedback. This is in line with findings from Klein and Rai (2009, pp. 735-736), who conclude that a lack of trust increases the fear of opportunistic behaviour. It is also in line with academic literature from Oyedijo et al. (2021, p. 20), who concluded that trust between SC actors has positive implications for multi-tier SC collaboration. If use-cases with suppliers have been developed, these can be used to convince other SC actors to get involved.

## 6.4 H1, H4, H5, H6 can be supported by the findings

*H1* stated that technology utilization factors are seen as a major barrier for sub-tier supplier involvement in multi-tier information sharing. This can be supported by our findings. It was mentioned that especially implementation costs should be regarded as a barrier. These costs are expected to play a more important role for higher-tier suppliers because supplier size in the automotive industry usually decreases while moving further upstream. Smaller size means also less available resources for the development of IT systems and associated training and education. These findings are in line with the literature (Harland et al., 2007, p. 1236). More research should be done to test if there is a correlation between supplier size and the importance of barriers from this category. Also, a decreasing IT maturity can play a role at smaller suppliers. Furthermore, it was mentioned that the centralized mindset of automotive OEM's could cause problems when data format standards are being imposed on sub-tier suppliers. However, there should be added that this centralized mindset is slowly transforming because of a market shift. The semiconductor crisis was mentioned as an example where they now have to compete with powerful players from the consumer electronics business over the supply of the same chips (Vakil, 2021). The automotive OEM's have realised they are not always the most powerful player anymore.

*H2* stated that legal aspects are seen as a major barrier. This can not be supported by our findings. In this research, legal aspects were rated as a minor challenge by the experts because everyone is aware of them and they are solvable. It is also likely that the characteristics of the information shared play a role. The research was about inventory data and production forecasts, these are not commonly seen as highly confidential. This indicates that there might be a relationship between the type of information shared in a multi-tier context, and the extent to which this category is perceived as a barrier. More research should be done to examine if this relationship is existing.

*H3* stated that information utilization factors are seen as a major barrier. This can be rejected by our findings. The experts rated this category with a mean 0f 0,8. Meaning it should not be regarded as an important barrier. It was mentioned that this is partly due to the maturity of SC actors active in the automotive industry who have been successfully dealing with fluctuating demands for decades. These outcomes are expected to differ among industries. More research could focus on the effect of industries/maturity of companies and the extent to which factors

of this category are perceived as a barrier. This is also in line with findings from S. Li and Lin (2006, p. 1653), who note that the extent to which information utilization factor play a role are likely to be influenced by industry and supplier size.

*H4* stated that business process aspects were seen as a major barrier. This hypothesis is also supported by our findings. Linking IT systems and benefit-sharing were deemed as important challenges. Interestingly. the views on risk-sharing were contradicting. X4 mentioned that risk-sharing mechanisms should be developed to support smaller sub-tier suppliers in the case they incur extra costs due to incorrect decisions based on wrong forecast data provided by the platform. However, X2 highlighted that risk-sharing is practically impossible. Also, it is too difficult to prove that certain costs are caused by incorrect data of the platform. "Correlation does not imply causation". X2 argued that risks for sub-tier suppliers automatically result in price increases. On the other hand, X4 argued that risks will always decrease with multi-tier information sharing so there is no need to share risks. More research about the practical feasibility of risk-sharing in SC chains is needed to draw conclusions.

*H5* stated that power structure aspects are not seen as a major barrier. This is supported by our findings. It is regarded as a minor challenge due to the fact that generally, power is decreasing when moving further upstream in the automotive industry. This is in line with the academic literature, where it is emphasized that automotive OEM's are able to control information sharing initiatives because of their power and legitimacy over other SC actors (Harland et al., 2007, p. 1251). Also, it was argued that firms with a powerful position, are very cautious with abusing their power. Therefore not many challenges are expected from this category. However, due to the electrification of vehicles and therefore automotive firms having to compete with other industries to source the same parts, the situation could change in the future. New suppliers will likely arise with more power.

*H6* stated that cultural factors are seen as a major barrier. This hypothesis is supported by our findings. Trust was deemed as the most important barrier in our research. This is due to the existence of often coercive relationships between automotive OEM's and their suppliers which has a negative impact on trust between SC actors. The existence of these barriers likely differs across different suppliers and sourced components. When business relationships are more collaborative it often increases trust. Therefore, differences in the importance of this barrier are expected across the supplier base. More research on the effects of coercive supplier relationships and the existence of cultural barriers should be done in order to draw more precise conclusions.

Interestingly, X1 and X2 mentioned during the interview that in their vision, more problems can be expected with first-tier supplier involvement instead of sub-tiers This is due to a lack of trust in their relationship with the OEM, and the fact there might be some first-tier suppliers that are providing little added value. They might be feared to give information concerning their suppliers, because of the risk of getting passed out. This is partly in line with findings from (M. M. Wilhelm et al., 2016, pp. 43, 55). They note that there is an important double agency role for first-tier suppliers in promoting multi-tier SC sustainability initiatives. More research is needed on whether their theory also applies for multi-tier information sharing of capacity and demand data.

# 7. CONCLUSION

Whereas previous research mainly focused on antecedents of information-sharing in a dyadic context (Autry et al., 2014; Caridi et al., 2014), this research moved beyond dyadic relationships and considered barriers and challenges towards multi-tier information sharing. This study supports existing academic literature by indicating that there is an increasing need for multi-tier information sharing (Dou et al., 2018; Sauer & Seuring, 2019; Tachizawa & Wong, 2014; Thome et al., 2014). It also builds on previous research by Kembro et al. (2017), who identified 6 categories consisting of 22 factors with potential barriers and challenges for multi-tier information sharing. This research aimed to identify which of these barriers are present within the automotive industry. In addition to that, the perceived importance of the different barriers is considered. It was found that technology utilization factors, legal aspects, business process aspects, power structure aspects, and cultural factors are regarded as barriers and challenges for multi-tier information sharing in the context of the automotive industry.

When comparing these barriers and challenges to previous research, it becomes clear that in the automotive industry not all antecedents are present and deemed as highly important. Cultural and business process aspects are regarded as the most important barriers. Technology utilization factors which include standardized data formats and implementation costs are also seen as a major barrier. Legal aspects and power structures aspects are perceived as minor barriers, the first due to the nature of the information shared (capacity and demand data) and the experience in data security, the latter due to the SC power characteristics of the automotive industry. Information utilization factors are not deemed as an important barrier due to the maturity of actors in the industry. Regulatory barriers and the already existence of a dominant platform were introduced as a new antecedent of multi-tier information sharing.

Theoretically, these findings provide some first insights into multi-tier information sharing in the context of the automotive industry. This addresses the research gap identified by Sauer and Seuring (2019, pp. 40-41), who call for more research on multi-tier SCM in industry-specific contexts.

Lastly, this study provides practical implications by investigating methods and strategies that can be used to overcome the identified barriers and stimulate sub-tier supplier involvement. It was found that to address the cultural and business process barriers, the way communication of multi-tier information sharing initiatives to sub-tier suppliers is deemed important. It is key that sub-tier suppliers are made aware of the benefits. Also, flexibility in supporting data inputs, management of data security, and the development of a technology roll-out strategy that prioritizes preferred suppliers was deemed important.

# 8. LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Information sharing in supply chains beyond the dyadic context is a new research topic which also means that academic literature is still scarce. This means that the antecedents in the research model are based on one of the first studies which moves beyond the dyads and have not been supported by other researchers yet. Therefore, it could be possible that other important antecedents of sub-tier supplier involvement in multi-tier information sharing are present which have not been considered in this research.

It should also be mentioned that the results of this qualitative research are only valid for this case, and can not be generalized due to a small sample size (Rahman, 2016, p. 105). Ideally, the sample size would have been larger, but due to a delayed supplier sounding board session which was supposed to be used as a data collection and time-constraints following that, it was not possible to find more participants. On the other hand, the conducted interviews were very in-depth and included the possibility of

asking sub-questions, which resulted in rich data inputs where also different perspectives were highlighted. Semi-structured interviews do have the disadvantage that the researcher can unintentionally influence the direction of the view by asking different questions. Ultimately, this could lead to some barriers being perceived as more or less important than they actually are.

Another limitation of this research is the lack of direct views from suppliers. Due to a change in data collection methods from supplier sounding board sessions, to expert interviews, no direct views of suppliers are part of the results. Findings in this research are based on interviews conducted with experts in the field of global SCM. Because of their experience as directors and their knowledge of the automotive industry their answers still provide valuable insights. Furthermore, we have seen in the research that the importance of different barriers is likely to be influenced by factors such as trust, and supplier size. Therefore, findings on the importance of barriers should not be generalized. Rather, there is a need for more research on how the previously mentioned factors influence the importance of barriers.

Moreover, many other research opportunities are emanating from the findings of this study. First, research on the effect of industry factors and supplier's size/maturity on the perceived importance of the different barriers could be useful. Especially, the relationship between technology utilization and supplier size is interesting because this category considers factors such as implementation cost, where it is likely that there is a relationship between the availability of resources and the perceived importance of the barrier. It would also be interesting to consider the relationship between the type of industry and power structure barriers. It is likely that in industries where one dominant player is absent, these barriers are perceived. Another interesting topic could be the effects of culture on suppliers' willingness to share information. It was mentioned that some barriers can be expected to be of different importance in particular continents.

Finally, more research is needed on successful methods and strategies which are used in practice to overcome barriers towards multi-tier information sharing. For example, the issues related to benefit sharing. It would be interesting to conduct in-depth case studies to find out if focal companies have found a way to share benefits arising from multi-tier information sharing in a fairway.

# 9. RECOMMENDATIONS TO COMPANY X

Based on the input gathered in the literature, interviews, and new insights developed during the process, several recommendations can be made to company X. They want to replace their current supplier platform A, with platform X which involves multi-tier information sharing. We are able to make several recommendations that can be useful for them to overcome barriers and challenges towards sub-tier supplier involvement.

The first recommendation is the creation of a communication/marketing team that should focus on the communication of platform X to (sub-tier)suppliers. A lack of trust between SC actors and the OEM is seen as the most important barrier. Also, a lack of benefit awareness of multi-tier information sharing at sub-tier suppliers was noted. This could partly be overcome by the development of a communication strategy. It is important that platform X is seen by suppliers as a collaboration project, and not another IT project. Humanity should come first when developing a platform. Furthermore, they should be made aware of the benefits of sharing capacity and demand data. For example a reduction of the bullwhip effect.

The second recommendation to overcome trust barriers and stimulate involvement in the development of a technology roll-out strategy where strategic parts and preferred suppliers are prioritized. The benefits of sharing capacity and demand data are not equal across all sourced components. To develop use-cases and gradually improve the platform it is advised to start with strategic products and preferred suppliers. They might be more willing to share information and collaborate. Also, it is easier to make benefits visible for products that currently have low supply assurance or high supply disruption costs. It is therefore recommended to start platform X with these critical components. An example is the supply of cobalt. Furthermore, SC actors involved in those products are likely to have an increased understanding of the need for multi-tier information sharing and how such a platform can help them. This should make involvement easier.

The third recommendation is to prioritize the flexibility of supported data inputs on the platform. In our research, it was mentioned that imposing data standards is not likely to stimulate sub-tier supplier involvement. Rather there should be compatibility with commonly-used ERP systems, as well as compatibility with smaller ERP system providers and also excel data inputs. Especially, smaller suppliers which can often be found in higher tier levels would benefit from this, because they often do not have the commonly-used ERP systems in place. For them, there should the possibility of providing simple data inputs such as excel files.

The fourth recommendation to company X based on this research is to prioritize data security in the development of platform X. An encrypted way of sending data is deemed important. Also, suppliers want to be able to decide which of their data is shared with whom. In other words, a function is advised where suppliers can decide on which tier level the SC actors can see their data such as inventory levels is advised. Technically, this could be done in a way that the platform is still able to send alerts while exact inventory levels are not visible for users. Also, the deletion of data should be thoroughly considered.

The final recommendations concerns benefit sharing. A thorough internal calculation of expected cost savings at company X due to a decrease in SC disruption costs should be made to further assess the possibilities for benefit sharing. Furthermore, sub-tier suppliers might be interested in obtaining a sub-tier supplier certificate. This could be awarded to those who are involved on the platform. It is recommended to further assess the practical possibilities of this.

# 10. ACKNOWLEDGMENTS

Via this way, I would like to express my gratitude to the following people which have helped throughout this thesis. Firstly, my supervisor at company X for his guidance and efforts to try and get me involved throughout the weeks. I would also like to thank the experts that made time to participate in the interviews. Lastly, I want to thank Prof. Dr. Holger Schiele for supervising the thesis.

# 11. REFERENCES

Acocella, I. (2012). The focus groups in social research: advantages and disadvantages. *Quality & Quantity, 46*(4), 1125-1136. doi:10.1007/s11135-011-9600-4

Angulo, A., Nachtmann, H., & Waller, M. A. (2004). Supply Chain Information Sharing in a Vendor Managed Inventory Partnership. *Journal of Business Logistics, 25*(1), 101-120. doi:https://doi.org/10.1002/j.2158-1592.2004.tb00171.x

Autry, C. W., Williams, B. D., & Golicic, S. (2014). Relational and process multiplexity in vertical supply chain triads: An exploration in the U.S. restaurant industry.

*Journal of Business Logistics, 35*(1), 52-70. doi:10.1111/jbl.12034
Ballou, R. H., Gilbert, S. M., & Mukherjee, A. (2000). New managerial challenges from supply chain opportunities. *Industrial Marketing Management, 29*(1), 7-18. doi:Doi 10.1016/S0019-8501(99)00107-8
Bastian, J., & Zentes, J. (2013). Supply chain transparency as a key prerequisite for sustainable agri-food supply chain management. *The International Review of Retail, Distribution and Consumer Research, 23*(5), 553-570. doi:10.1080/09593969.2013.834836
Biktimirov, E. N., & Afego, P. N. (2021). Do Investors Value Environmental Sustainability? Evidence from the FTSE Environmental Opportunities 100 Index. *Finance Research Letters*, 102112. doi:https://doi.org/10.1016/j.frl.2021.102112
Boyce, C., Neale, P., & Pathfinder, I. (2006). *Conducting in-depth interviews : a guide for designing and conducting in-depth interviews for evaluation input*. Watertown, MA: Pathfinder International.
Brun, A., Karaosman, H., & Barresi, T. (2020). Supply Chain Collaboration for Transparency. *Sustainability, 12*(11). doi:10.3390/su12114429
Caridi, M., Moretto, A., Perego, A., & Tumino, A. (2014). The benefits of supply chain visibility: A value assessment model. *International Journal of Production Economics, 151*, 1-19. doi:10.1016/j.ijpe.2013.12.025
Carter, C. R., Rogers, D. S., & Choi, T. Y. (2015). Toward the Theory of the Supply Chain. *Journal of Supply Chain Management, 51*(2), 89-97. doi:10.1111/jscm.12073
Casper, R., & Sundin, E. (2020). Electrification in the automotive industry: effects in remanufacturing. *Journal of Remanufacturing*. doi:10.1007/s13243-020-00094-8
Chowdhury, P., Paul, S. K., Kaisar, S., & Moktadir, M. A. (2021). COVID-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E: Logistics and Transportation Review, 148*, 102271. doi:https://doi.org/10.1016/j.tre.2021.102271
Cramer, J. M. (2008). Organising corporate social responsibility in international product chains. *Journal of Cleaner Production, 16*(3), 395-400. doi:10.1016/j.jclepro.2007.01.007
Dou, Y. J., Zhu, Q. H., & Sarkis, J. (2018). Green multi-tier supply chain management: An enabler investigation. *Journal of Purchasing and Supply Management, 24*(2), 95-107. doi:10.1016/j.pursup.2017.07.001
Doz, Y. (2011). Qualitative research for international business. *Journal of International Business Studies, 42*(5), 582-590. Retrieved from http://www.jstor.org/stable/29789446
Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z. W., & Roubaudl, D. (2020). Upstream supply chain visibility and complexity effect on focal company's sustainable performance: Indian manufacturers' perspective. *Annals of Operations Research, 290*(1-2), 343-367. doi:10.1007/s10479-017-2544-x
Egels-Zanden, N., & Hansson, N. (2016). Supply Chain Transparency as a Consumer or Corporate Tool: The Case of Nudie Jeans Co. *Journal of Consumer Policy, 39*(4), 377-395. doi:10.1007/s10603-015-9283-7
Corporate due diligence and corporate acountability, A9-0018/2021 C.F.R. (2021).
Fawcett, S. E., Osterhaus, P., Magnan, G. M., Brau, J. C., & McCarter, M. W. (2007). Information sharing and supply chain performance: the role of connectivity and willingness. *Supply Chain Management-an International Journal, 12*(5), 358-368. doi:10.1108/13598540710776935
Fernandez-Feijoo, B., Romero, S., & Ruiz, S. (2014). Effect of Stakeholders' Pressure on Transparency of Sustainability Reports within the GRI Framework. *Journal of Business Ethics, 122*(1), 53-63. doi:10.1007/s10551-013-1748-5
Forslund, H., & Jonsson, P. (2007). The impact of forecast information quality on supply chain performance. *International Journal of Operations & Production Management, 27*(1), 90-107. doi:10.1108/01443570710714556
Fraser, I. J., Muller, M., & Schwarzkopf, J. (2020). Transparency for Multi-Tier Sustainable Supply Chain Management: A Case Study of a Multi-tier Transparency Approach for SSCM in the Automotive Industry. *Sustainability, 12*(5). doi:10.3390/su12051814
Funda, S. A., & Robinson, E. P. (2005). Information sharing and coordination in make-to-order supply chains. *Journal of Operations Management, 23*(6), 579-598. doi:10.1016/j.jom.2004.08.007
Gardner, T. A., Benzie, M., Borner, J., Dawkins, E., Fick, S., Garrett, R., . . . Wolvekamp, P. (2019). Transparency and sustainability in global commodity supply chains. *World Development, 121*, 163-177. doi:10.1016/j.worlddev.2018.05.025
Gold, S., & Heikkurinen, P. (2018). Transparency fallacy: Unintended consequences of stakeholder claims on responsibility in supply chains. *Accounting Auditing & Accountability Journal, 31*(1), 318-337. doi:10.1108/Aaaj-06-2015-2088
Gunasekaran, A., Subramanian, N., & Rahman, S. (2015). Green supply chain collaboration and incentives: Current trends and future directions. *Transportation Research Part E-Logistics and Transportation Review, 74*, 1-10. doi:10.1016/j.tre.2015.01.002
Handfield, R. (2017). Preparing for the Era of the Digitally Transparent Supply Chain: A Call to Research in a New Kind of Journal. *Logistics, 1*(1). doi:10.3390/logistics1010002
Harland, C. M., Caldwell, N. D., Powell, P., & Zheng, J. (2007). Barriers to supply chain information integration: SMEs adrift of eLands. *Journal of Operations Management, 25*(6), 1234-1254. doi:10.1016/j.jom.2007.01.004
Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research, 58*(10), 2904-2915. doi:10.1080/00207543.2020.1750727
Kallio, H., Pietila, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954-2965. doi:10.1111/jan.13031
Kembro, J., Naslund, D., & Olhager, J. (2017). Information sharing across multiple supply chain tiers: A Delphi study on antecedents. *International Journal of Production Economics, 193*, 77-86. doi:10.1016/j.ijpe.2017.06.032
Kembro, J., & Selviaridis, K. (2015). Exploring information sharing in the extended supply chain: an

interdependence perspective. *Supply Chain Management-an International Journal, 20*(4), 455-470. doi:10.1108/Scm-07-2014-0252

Klein, R., & Rai, A. (2009). Interfirm Strategic Information Flows in Logistics Supply Chain Relationships. *Mis Quarterly, 33*(4), 735-762. Retrieved from <Go to ISI>://WOS:000272211500008

Li, J. Q., Sikora, R., Shaw, M. J., & Tan, G. W. (2006). A strategic analysis of inter organizational information sharing. *Decision Support Systems, 42*(1), 251-266. doi:10.1016/j.dss.2004.12.003

Li, L., & Zhang, H. (2008). Confidentiality and Information Sharing in Supply Chain Coordination. *Management Science, 54*(8), 1467-1481. doi:10.1287/mnsc.1070.0851

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

Liu, Y. (2015). Dynamic study on the influencing factors of industrial firm's carbon footprint. *Journal of Cleaner Production, 103*, 411-422. doi:10.1016/j.jclepro.2014.06.029

Maihold, G., Müller, M., Saulich, C., & Schöneich, S. (2021). *Responsibility in Supply Chains: Germany's Due Diligence Act Is a Good Start*. Retrieved from Berlin: https://www.swp-berlin.org/fileadmin/contents/products/comments/2021C21_Responsibility_Supply_Chains.pdf

Mol, A. P. J. (2015). Transparency and value chain sustainability. *Journal of Cleaner Production, 107*, 154-161. doi:10.1016/j.jclepro.2013.11.012

Muller, J. M., Veile, J. W., & Voigt, K. I. (2020). Prerequisites and incentives for digital information sharing in Industry 4.0-An international comparison across data types. *Computers & Industrial Engineering, 148*. doi:10.1016/j.cie.2020.106733

Nooraie, S. V., & Parast, M. M. (2015). A multi-objective approach to supply chain risk management: Integrating visibility with supply and demand risk. *International Journal of Production Economics, 161*, 192-200. doi:10.1016/j.ijpe.2014.12.024

Noti, K., Mucciarelli, F., Angelici, C., Pozza, V., & Pillinini, M. (2020). *Corporate social responsibility (CSR) and its implementation into EU Company law*. Retrieved from Brussels: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658541/IPOL_STU(2020)658541_EN.pdf

Opdenakker, R. (2006). Advantages and Disadvantages of Four Interview Techniques in Qualitative Research [Electronic Journal]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 7*.

Oyedijo, A., Yang, Y., Koukpaki, A. S. F., & Mishra, N. (2021). The role of fairness in multi-tier sustainable supply chains. *International Journal of Production Research*. doi:10.1080/00207543.2021.1928319

Patnayakuni, R., Rai, A., & Seth, N. (2006). Relational antecedents of information flow integration for supply chain coordination. *Journal of Management Information Systems, 23*(1), 13-49. doi:Doi 10.2753/Mis0742-1222230101

Pires, S. R. I., & Neto, M. S. (2008). New configurations in supply chains: the case of a condominium in Brazil's automotive industry. *Supply Chain Management-an International Journal, 13*(4), 328-334. doi:10.1108/13598540810882215

Porterfield, T. E., Bailey, J. P., & Evers, P. T. (2010). B2B eCommerce: an empirical investigation of information exchange and firm performance. *International Journal of Physical Distribution & Logistics Management, 40*(6), 435-455. doi:10.1108/09600031011062182

Rahman, M. (2016). The Advantages and Disadvantages of Using Qualitative and Quantitative Approaches and Methods in Language "Testing and Assessment" Research: A Literature Review. *Journal of Education and Learning, 6*, 102. doi:10.5539/jel.v6n1p102

Ramanathan, U., Bentley, Y., & Pang, G. (2014). The role of collaboration in the UK green supply chains: an exploratory study of the perspectives of suppliers, logistics and retailers. *Journal of Cleaner Production, 70*, 231-241. doi:10.1016/j.jclepro.2014.02.026

Rebs, T., Brandenburg, M., & Seuring, S. (2019). System dynamics modeling for sustainable supply chain management: A literature review and systems thinking approach. *Journal of Cleaner Production, 208*, 1265-1280. doi:10.1016/j.jclepro.2018.10.100

Ruf, B. M., Muralidhar, K., Brown, R. M., Janney, J. J., & Paul, K. (2001). An empirical investigation of the relationship between change in corporate social performance and financial performance: A stakeholder theory perspective. *Journal of Business Ethics, 32*(2), 143-156. doi:Doi 10.1023/A:1010786912118

Ruggie, J. G., Tamaryn Nelson. (2015). Human Rights and the OECD Guidelines for Multinational Enterprises: Normative Innovations and Implementation Challenges. *Corporate Social Responsibility Initiative Working Paper No. 66*(John F. Kennedy School of Government, Harvard University).

Sauer, P. C., & Seuring, S. (2019). Extending the reach of multi-tier sustainable supply chain management - Insights from mineral supply chains. *International Journal of Production Economics, 217*, 31-43. doi:10.1016/j.ijpe.2018.05.030

Saunders, B., Kitzinger, J., & Kitzinger, C. (2015). Anonymising interview data: challenges and compromise in practice. *Qual Res, 15*(5), 616-632. doi:10.1177/1468794114550439

Simatupang, T. M., & Sridharan, R. (2002). The Collaborative Supply Chain. *The International Journal of Logistics Management, 13*(1), 15-30. doi:10.1108/09574090210806333

Smit, L., Holly, G., McCorquodale, R., & Neely, S. (2020). Human rights due diligence in global supply chains: evidence of corporate practices to inform a legal standard. *International Journal of Human Rights*. doi:10.1080/13642987.2020.1799196

Sobral, M. C., Jabbour, A. B. L. d., & Chiappetta, C. J. (2013). Green Benefits From Adopting Lean Manufacturing: A Case Study From the Automotive Sector. *Environmental Quality Management, 22*(3), 65-72. doi:10.1002/tqem.21336

Sodhi, M. S., & Tang, C. S. (2019). Research Opportunities in Supply Chain Transparency. *Production and Operations Management, 28*(12), 2946-2959. doi:10.1111/poms.13115

Soosay, C. A., & Hyland, P. (2015). A decade of supply chain collaboration and directions for future research. *Supply Chain Management: An International Journal, 20*(6), 613-630. doi:10.1108/SCM-06-2015-0217

Steers, S. (2021, 12/04/2021). Supply chain risks under review after Suez canal blockage. *SupplyChain Digital*.

Retrieved from https://www.supplychaindigital.com/supply-chain-risk-management/supply-chain-risks-under-review-after-suez-canal-blockage

Tachizawa, E. M., & Wong, C. Y. (2014). Towards a theory of multi-tier sustainable supply chains: a systematic literature review. *Supply Chain Management-an International Journal, 19*(5-6), 643-663. doi:10.1108/Scm-02-2014-0070

Thome, A. M. T., Scavarda, L. F., Pires, S. R. I., Ceryno, P., & Klingebiel, K. (2014). A multi-tier study on supply chain flexibility in the automotive industry. *International Journal of Production Economics, 158*, 91-105. doi:10.1016/j.ijpe.2014.07.024

Tjahjono, B., Esplugues, C., Ares, E., & Pelaez, G. (2017). What does Industry 4.0 mean to Supply Chain? *Manufacturing Engineering Society International Conference 2017 (Mesic 2017), 13*, 1175-1182. doi:10.1016/j.promfg.2017.09.191

Trienekens, J. H., Wognum, P. M., Beulens, A. J. M., & van der Vorst, J. G. A. J. (2012). Transparency in complex dynamic food supply chains. *Advanced Engineering Informatics, 26*(1), 55-65. doi:10.1016/j.aei.2011.07.007

Vakil, B. L., Tom. (2021). Why We're in the Midst of a Global Semiconductor Shortage. *Supply Chain.* Retrieved from https://hbr.org/2021/02/why-were-in-the-midst-of-a-global-semiconductor-shortage

van Tulder, R., van Wijk, J., & Kolk, A. (2009). From Chain Liability to Chain Responsibility. *Journal of Business Ethics, 85*, 399-412. doi:10.1007/s10551-008-9742-z

Vanalle, R. M., Lucato, W. C., Ganga, G. M. D., & Alves, A. G. (2020). Risk management in the automotive supply chain: an exploratory study in Brazil. *International Journal of Production Research, 58*(3), 783-799. doi:10.1080/00207543.2019.1600762

Vanalle, R. M., Lucato, W. C., & Santos, L. B. (2011). Environmental Requirements in the Automotive Supply Chain - An Evaluation of a First Tier Company in the Brazilian Auto Industry. *2011 3rd International Conference on Environmental Science and Information Application Technology Esiat 2011, Vol 10, Pt A, 10*, 337-343. doi:10.1016/j.proenv.2011.09.055

Verband der Automobilindustrie. (2020). Supply chain management in the aftermarket. Retrieved from https://www.vda.de/en/association/departments/department-aftermarket/supply-chain-management.html

Wang-Mlynek, L., & Foerstl, K. (2020). Barriers to multi-tier supply chain risk management. *International Journal of Logistics Management, 31*(3), 465-487. doi:10.1108/Ijlm-09-2019-0256

Wang, X., & Disney, S. M. (2016). The bullwhip effect: Progress, trends and directions. *European Journal of Operational Research, 250*(3), 691-701. doi:10.1016/j.ejor.2015.07.022

Wilhelm, M., Blome, C., Wieck, E., & Xiao, C. Y. (2016). Implementing sustainability in multi-tier supply chains: Strategies and contingencies in managing sub-suppliers. *International Journal of Production Economics, 182*, 196-212. doi:10.1016/j.ijpe.2016.08.006

Wilhelm, M. M., Blome, C., Bhakoo, V., & Paulraj, A. (2016). Sustainability in multi-tier supply chains: Understanding the double agency role of the first-tier supplier. *Journal of Operations Management, 41*, 42-60. doi:10.1016/j.jom.2015.11.001

Yadav, P. L., Han, S. H., & Rho, J. J. (2016). Impact of Environmental Performance on Firm Value for Sustainable Investment: Evidence from Large US Firms. *Business Strategy and the Environment, 25*(6), 402-420. doi:10.1002/bse.1883

Yu, M. M., Ting, S. C., & Chen, M. C. (2010). Evaluating the cross-efficiency of information sharing in supply chains. *Expert Systems with Applications, 37*(4), 2891-2897. doi:10.1016/j.eswa.2009.09.048

Zamfir, I. (2020). *Towards a mandatory EU system of due diligence for supply chains*. Retrieved from Brussels: https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659299/EPRS_BRI(2020)659299_EN.pdf

Zhu, Q. H., Sarkis, J., & Lai, K. H. (2013). Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management, 19*(2), 106-117. doi:10.1016/j.pursup.2012.12.001

# APPENDICES

## Appendix A – Table 1: Antecedents of information sharing in a dyadic context (Kembro et al., 2017, p. 79)

**Table 1**
Factors that must be addressed to enable dyadic information sharing.

| Factor | Description | Sources |
|---|---|---|
| Information quality | Without proper formatting, timeliness and reliability, the shared information is of little value to the receiver. | Monczka et al. (1998); Lee and Whang (2000); Moberg et al. (2002); Childerhouse et al. (2003); Angulo et al. (2004); Barratt (2004); Li and Lin (2006); Li et al. (2006); Forslund and Jonsson (2007) |
| Costly and inadequate information systems | Partners may have different systems in place that are not compatible, and the implementation of new IT systems may be negatively perceived due to lack of incentives. The means for sharing information may require high capital investments. | Christopher and Jüttner (2000); Lee and Whang (2000); Frohlich (2002); Childerhouse et al. (2003); Shore and Venkatachalam (2003); Kelle and Akbulut (2005); Patnayakuni et al. (2006); Fawcett et al. (2007); Harland et al. (2007); Fawcett et al. (2008) |
| Power asymmetry | Fear amongst partners to become overly dependent on each other. Firms may fear losing the favorable position and bargaining power in a supplier-buyer relationship. | Seidmann and Sundararajan (1998); Mason-Jones and Towill (1999); Ballou et al. (2000); Christopher and Jüttner (2000); Lee and Whang (2000); Frohlich (2002); Li and Lin (2006); Fawcett et al. (2007); Harland et al. (2007) |
| Governance/ dominant player | Due to the disintegrated structures of supply chain, there is a lack of governance on how the chain is directed and controlled. | Childerhouse et al. (2003); Fawcett et al. (2008) |
| Trust | Fear of opportunistic behavior may reduce willingness to share due to the risk of information leakage to competitors. | Moorman et al. (1992); Cooper et al. (1997); Seidmann and Sundararajan (1998); Spekman et al. (1998); Barratt (2004); Kelle and Akbulut (2005); Li and Lin (2006); Fawcett et al. (2007); Klein and Rai (2009); Porterfield et al. (2010) |
| Benefits allocation | Unfair distribution of rewards of information sharing between involved partners. | Mason-Jones and Towill (1999); Ballou et al. (2000); Lee and Whang (2000); Childerhouse et al. (2003); Sahin and Robinson (2005); Harland et al. (2007); Fawcett et al. (2008) |
| Common performance metrics | Lack of common performance indicators for capturing benefits related to inter-organizational information sharing. | Ballou et al. (2000); Barratt (2004); Kelle and Akbulut (2005); Fawcett et al. (2008) |
| Common goals | Diverse goals of partners make it difficult to achieve necessary changes in business culture for enabling information sharing. | Kelle and Akbulut (2005); Harland et al. (2007); Fawcett et al. (2008) |
| Confidential information | Fear of losing control of sensitive data that could reduce competitiveness in the marketplace. | Lee and Whang (2000); Frohlich (2002); Lau et al. (2004); Kelle and Akbulut (2005); Li and Zhang (2008); Porterfield et al. (2010) |

## Appendix B – Interview questions

**English version:**

Question 1: Do you have any experience with multi-tier SC initiatives? If so, could you give a brief example?

Question 2: Do you feel that there is an increasing need to adopt multi-tier information sharing initiatives within supply chains?

Question 3: How do factors connected to multi-tier information sharing act as barriers and challenges when trying to involve sub tier suppliers? (Separated by the 6 cateogries)

> 3.1: To what extent do you think that technology utilization factors act as barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?
>
> 3.2: To what extent do you think that legal aspects act as barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?
>
> 3.3: To what extend do you think that cultural aspects act as barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?

3.4 To what extend do you think that information utilization factors act a barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?

3.5 To what extent do you think business process aspects act as barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?

3.6 To what extent do you think power structure aspects act as barriers or challenges towards involvement of sub tier suppliers in information sharing, and do you have ideas on how to overcome those challenges?

Question 4: On a scale from 0-4, could you rate the previously mentioned barriers and challenges regarding their importance? ( 0 as not important, 4 as very important)

Question 5: Do you foresee any other barriers or challenges towards involvement of sub tier suppliers in information sharing initiatives?

**Dutch version:**

Doel: Het verkrijgen van input van experts over belemmeringen en uitdagingen die een rol spelen bij het stimuleren van de betrokkenheid van sub-tier leveranciers bij SC samenwerking initiatieven.

Vraag 1: Heeft u ervaring met multi-tier SC projecten? Zo ja, kunt u een voorbeeld geven?

Vraag 2: Heeft u het gevoel dat er een toenemende noodzaak is voor multi-tier information sharing projecten?

Vraag 3: Hoe dragen factoren die verband houden met multi-tier information sharing bij als belemmeringen en uitdagingen bij het betrekken van sub-tier leveranciers?

3.1 In hoeverre denkt u dat *technologie utilization factors* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing, en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

3.2 In hoeverre denkt u dat *legal aspects* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing, en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

3.3 In hoeverre denkt u dat *cultural aspects* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

3.4 In hoeverre denkt u dat *information utilization apsects* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

3.5 In hoeverre denkt u dat *business process aspects* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

3.6 In hoeverre denkt u dat *power structure aspects* een barrière of uitdaging vormen voor het betrekken van sub-tier leveranciers bij multi-tier information sharing en heeft u ideeën over hoe deze uitdagingen overwonnen kunnen worden ?

Vraag 4: Op een schaal van 0-4, kunt u de hiervoor genoemde belemmeringen en uitdagingen beoordelen op hun belang?

Vraag 5: Voorziet u nog andere (niet genoemde) barrières en uitdagingen op het gebied van betrokkenheid van sub-tier leveranciers bij SC samenwerkingsprojecten?

## Appendix C – Transcript of interviews

Left out due to confidentiality

## Appendix D – Detailed description of results

**Table 2: Importance ratings of barriers and challenges grouped by experts**

| Barrier/challenge | X1 | X2 | X3 | X4 | X5 |
|---|---|---|---|---|---|
| Technology utilization | 3 | 2 | 4 | 3 | 3 |
| Legal | 2 | 1 | 2 | 2 | 1 |
| Information utilization | 0 | 0 | 2 | 1 | 1 |
| Business process | 3 | 3 | 3 | 4 | 4 |
| Power structure | 1 | 2 | 1 | 2 | 0 |
| Cultural | 2 | 4 | 4 | 4 | 3 |

**Table 3: Overview of the mean and Stdev of importance ratings from table 2**

| Barrier/challenge | Mean | Stdev |
|---|---|---|
| Technology utilization | 3 | 0,707 |
| Legal aspects | 1,6 | 0,548 |
| Information utilization | 0,8 | 0,837 |
| Business process | 3,4 | 0,548 |
| Power structure | 1,2 | 0,837 |
| Cultural aspects | 3,4 | 0,894 |