THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The value of information sharing in automotive supply chains

Understanding the role of information utilisation for operations planning and control

PAULINA MYRELID

Department of Technology Management and Economics

CHALMERS UNIVERSITY OF TECHNOLOGY

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Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

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Abstract

The purpose of the thesis is to provide knowledge about the role of information utilisation in suppliers' operations planning and control (OPC) processes, for generating value of shared demand-related information in automotive supply chains. To do so, the thesis focuses on information utilisation from three different perspectives: (1) how suppliers utilise shared information; (2) why they utilise the information the way they do; and (3) the effect of the utilisation.

The thesis is based on three research studies, two case studies and one survey study, all performed in the Swedish automotive industry. The thesis contains both qualitative and quantitative data, which enables both a deep understanding of the studied phenomena, as well as general descriptions and explanations of it. The results from the research studies are presented in five academic papers, which are appended in the thesis.

The thesis describes suppliers in the automotive industry divided into four clusters, depending on how they utilise three types of shared demand-related information in their OPC processes. Moreover, the thesis shows how an inter-organisational collaborative relationship, as well as intra-organisational process support at a supplier impact how suppliers utilise shared information both directly and indirectly, through information quality (IQ). Furthermore, the thesis explains that information utilisation mediates the relationship between IQ and OPC performance, but also that the mediation differs between different types of shared information.

The thesis contributes to academia by highlighting the critical role of information utilisation for generating value of shared demand-related information. It develops a five-phase conceptual model of the impact of information sharing on OPC performance and explains how this model differs between different types of shared demand-related information. Additionally, the thesis opens up further research into information utilisation by defining and operationalising the information utilisation concept.

The research contributes to practitioners in the automotive industry by showing that the potential value of information sharing is far from reached in the industry and that its value can be improved by better utilisation of shared demand-related information. It develops an information utilisation maturity model, which can be used as guidance for both suppliers and OEMs, in their endeavour to improve the value of information sharing in the automotive industry.

List of appended papers

Paper I
Myrelid, P. (2017). Information quality deficiencies in delivery schedules and their impact on production scheduling. *Production Planning and Control*, Vol. 28, No. 3, pp. 232-243.

Paper II
Jonsson, P., & Myrelid, P. (2016). Supply chain information utilisation: conceptualisation and antecedents. *International Journal of Operations and Production Management*, Vol. 36, No. 12, pp. 1769-1799.

Paper III
Myrelid, P. & Jonsson, P. (2019). Determinants of information quality in dyadic supply chain relationships. *The International Journal of Logistics Management*, Vol. 30 No. 1, pp. 356-380.

Paper IV
Myrelid, P., Wänström, C., & Jonsson, P. (2021). Supply chain information utilisation in the automotive industry: A cluster analysis.

Paper V
Myrelid, P., & Jonsson, P. (2021). The performance effect of supply chain information quality and utilisation.

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Paulina Myrelid
Arboga, May 2021

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1 Introduction

This thesis deals with the operations planning and control (OPC) processes carried out by suppliers in the automotive industry. This first chapter of the thesis provides a short background and explains the importance of suppliers utilising shared demand-related information from customers in its OPC processes. Furthermore, the chapter describes the research problem and explains why the concept of information utilisation is relevant as a solution. Moreover, the chapter introduces the purpose and scope of the thesis and ends up with a disposition of the forthcoming chapters of the thesis.

1.1 Background

The OPC processes are vital for any manufacturing company, as they support the decisions of when, what, and how much to produce, to balance supply and demand (Jonsson & Mattsson, 2009; Jacobs et al., 2011). For a company to stay competitive in today's ever-changing business environment (see e.g., Affonso et al., 2008; Christopher & Holweg, 2011; Williams et al., 2013; Munir et al., 2020), it continuously needs to improve customer satisfaction while at the same time reduce the need for resources (Slack et al., 2010). Despite different principles and techniques of the OPC processes being researched from the early 1900s (e.g., Harris, 1913; Wilson, 1934), until the end of the same century, such research solely focused on internal conditions for manufacturing operations (Olhager, 2013). Since then, it has been concluded that companies cannot work in isolation, and they instead need to include the supply chain in their strive for competitive advantage (see e.g., Frohlich & Westbrook, 2001; Flynn et al., 2010; Ataseven & Nair, 2017; Shou et al., 2018).

The OPC processes are based on demand-related information, e.g., trends and forecasts, planned and firm customer orders, inventory levels, and point-of-sales data (Jonsson & Mattsson, 2013). Though the information can be available either internally or shared by other actors in the supply chain (Barratt & Barratt, 2011), demand-related information is commonly shared by downstream actors, i.e., customers. Information sharing between supply chain actors has been extensively studied in academia for several decades (see e.g., Forrester, 1958; Cachon & Fisher, 2000; Lee & Whang, 2000; Yu et al., 2001; Zhou & Benton, 2007) and has been pointed out as important for supply chain performance (Paulraj et al., 2008; Ramayah & Omar, 2010; Laosirihongthong et al., 2011; Sanders et al., 2012; Şahin & Topal, 2019). For planning purposes, information sharing has been shown to both reduce inventory levels as well as improve customer satisfaction (Sahin & Robinson Jr, 2005; Simatupang & Sridharan, 2005; Wu & Cheng, 2008; Datta & Christopher, 2011).

The automotive industry has gone through a substantial shift in production during recent decades, changing the requirements for the OPC processes in the industry. First, a growing number of vehicle variants has led to an increased amount of part numbers used for production (Bennett & Klug, 2012), which has amplified demand fluctuations (Holweg et al., 2011; Dwaikat et al., 2018) and created planning difficulties (Berry & Cooper, 1999) in the industry. Second, the trends of outsourcing processes and applying just-in-time principles has transferred many of the original equipment manufacturers' (OEMs) planning difficulties to the suppliers (Bennett & Klug, 2012). At the same time, the automotive industry has continuously been in the forefront for developing the OPC processes. Information technology (IT) systems were adopted to speed up the OPC processes already in the 1960s (Gobetto, 2014) and almost all suppliers in the industry have been using electronic data interchange (EDI) to receive demand-related information from the OEMs since the 1990s (Reekers & Smithson, 1996). The OEMs commonly share several types of demand-related information with their suppliers, e.g., trends

and forecasts, planned and firm orders and inventory levels (Bennett & Klug, 2012), as well as forecast accuracy measurements (Bystedt, 2015), which thereby is available for the automotive industry suppliers' OPC processes.

1.2 Research problem

Even though many researchers show a positive relationship between information sharing and performance (e.g., Paulraj et al., 2008; Ramayah & Omar, 2010; Laosirihongthong et al., 2011; Sanders et al., 2012; Şahin & Topal, 2019; Alzoubi & Yanamandra, 2020), the actual value of information sharing is neither clear nor consistent in previous research (Ketzenberg et al., 2007; Jonsson & Mattsson, 2013). Some researchers are unable to confirm a relationship between information sharing and performance (e.g., Krause et al., 2007; Field & Meile, 2008; Tan et al., 2010; Liu et al., 2013) and some even argue that more information sharing does not necessarily improve performance (e.g., Fabbe-Costes & Jahre, 2008; Chan & Chan, 2009). Even though the determinants of information sharing (i.e., how information sharing is achieved) is extensively studied in previous research (by e.g., Li & Lin, 2006; Lee et al., 2010; Chen et al., 2014), few companies have reached the full potential with information sharing in practice, despite their investments in information sharing initiatives (Fawcett et al., 2009). Thus, there is a need to extend the knowledge about the relationship between information sharing and performance, to understand how the potential benefits with information sharing in supply chains can be reached.

Several researchers argue that information quality (IQ) is a mediator between information sharing and performance (e.g., Barratt & Oke, 2007; Hartono et al., 2010; Wiengarten et al., 2010; Ji-fan Ren et al., 2017) and thus explains the previously conflicting results regarding the value of information sharing with the existence of IQ deficiencies in the shared information. However, the relationship between IQ and performance is neither indisputable, as e.g., Forslund and Jonsson (2007) were unable to significantly show such relationship. Also, IQ is a multi-dimensional concept (Wang et al., 1996; Lee et al., 2002), which is not consistently defined in previous research, as different researchers include different dimensions in their IQ-related studies (Gustavsson & Wänström, 2009). More nuanced studies on IQ are thus needed to understand its mediating role between information sharing and performance.

As neither the value of information sharing nor the value of IQ is fully clear in previous research, it is likely that other mediators or moderators of the relationship between information sharing, IQ, and performance exist. Lately, a few researchers have argued that the shared information needs to be utilised for the potential benefits with information sharing to occur (Kiil et al., 2019; Sener et al., 2019). Even though this is logical, information utilisation is seldom explicitly studied in previous research. Instead, the value of information sharing is often based on information availability (Viet et al., 2018), which presumes that available information by default is utilised. Little is known about what determines information utilisation and how it mediates the relationship between information sharing, IQ, and performance. Nevertheless, this understanding is important, as it helps explain the conflicting results regarding the value of information sharing and IQ in previous research. The relationship between information sharing and OPC performance should at least be described as a four-stage process, mediated by both the quality and the utilisation of the shared information (see Figure 1).

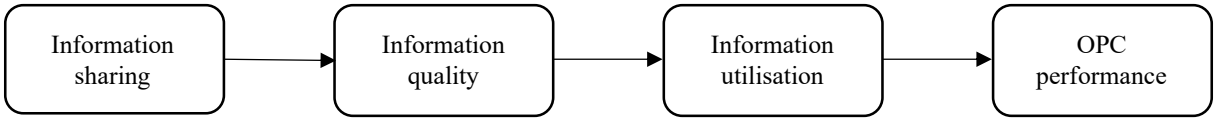

Figure 1 – Relationship between information sharing and OPC performance.

The concept of information utilisation is not only unexplored in previous research, but it is similarly unexplored in practice. Even though several types of demand-related information are shared within the automotive industry (Bennett & Klug, 2012), the OEMs do not know if and how the suppliers utilise the different types of shared information. Furthermore, a study in the automotive industry shows that the quality of shared information is far from satisfactory (Bystedt, 2015), however, it is not known how these IQ deficiencies impact the suppliers' utilisation of the shared information in their OPC processes.

1.3 Purpose

The purpose of the thesis is to provide knowledge about the role of information utilisation in suppliers' operations planning and control processes, for generating value of shared demand-related information in automotive supply chains.

1.4 Scope

Although understanding the mediating role of information utilisation between information sharing, IQ, and performance should be important in many different industries, the research in this thesis focuses solely on the automotive industry. The automotive industry is an appropriate empirical setting for the research, as OEMs in the industry have, for a long time, shared large amounts of demand-related information with their suppliers (see e.g., Reekers & Smithson, 1996; Bennett & Klug, 2012), which is a prerequisite for information utilisation. Also, the planning difficulties for suppliers in the automotive industry (see e.g., Berry & Cooper, 1999; Bennett & Klug, 2012) emphasise the need for improving the OPC processes in the industry. Furthermore, Harrison and Van Hoek (2008) argue that as much as 80-90 percent of the value-adding in many automotive supply chains are performed by the suppliers, indicating that the performance of the suppliers' OPC processes has substantial impact on the performance of the entire automotive supply chains.

Several types of demand-related information are shared between actors in automotive supply chains, e.g., trends and forecasts, planned and firm orders, inventory levels (Bennett & Klug, 2012) and forecast accuracy measurements (Bystedt, 2015). Even though point-of-sales data are extensively studied in previous research (Huang et al., 2003), it is not as commonly shared in the automotive industry as the other types of demand-related information and is thus not studied here. Also, the technology development has enabled the sharing of, for example, big data, however, the focus in this thesis is the demand-related information commonly shared within the automotive industry. Furthermore, information can be shared both formally and informally, where formal information sharing is regularized and structured, while informal information sharing is non-regularized and spontaneous (Mohr & Nevin, 1990). The research in this thesis mainly focuses on the formal types of information sharing. Even though both formal and informal information sharing is common in the automotive industry, formal information is considered the basis of the OEM's information sharing strategies and is thus relevant for the scope of this thesis.

Information sharing can be performed between several different actors in a supply chain, which are not only adjacent (Huang et al., 2003). However, this research mostly focuses on information sharing in dyadic relationships. This, again, does not mean that information sharing between other or more actors in a supply chain is irrelevant or of less importance than dyadic information sharing. Still, several types of demand-related information are shared between OEMs and first-tier suppliers in the automotive industry (Bennett & Klug, 2012; Bystedt, 2015), making dyadic information sharing relevant for this research.

OPC processes are performed on operational, tactical, and strategic planning levels (Jonsson & Mattsson, 2009; Jacobs et al., 2011) and the research in this thesis focuses on the operational and tactical levels. This does not mean that information sharing, IQ, and information utilisation is irrelevant for strategic planning or that strategic planning is of less importance than operational and tactical planning. However, shared demand-related information is commonly utilised in the operational and tactical OPC processes (i.e., forecasting process, production planning process, master production scheduling (MPS) process, material planning process, and order delivery process) at many suppliers in the automotive industry, leading to the scope being relevant for this research.

The value of information sharing can be seen in several different supply chain processes and be assessed in numerous different ways (see e.g. Li et al., 2005; Cai et al., 2006; Prajogo & Olhager, 2012; Babai et al., 2013), however, in this research it implies the performance of the OPC processes. Beamon (1999) argue that there are three aspects of supply chain performance: output, resources, and flexibility. However, in accordance with Forslund and Jonsson (2007), the research in this thesis focuses on the output and resource performance, whereas flexibility performance is only indirectly included, as it should impact output and resource performance in unstable environments.

1.5 Thesis outline

Chapter 1 (*Introduction*) presents the background, research problem, purpose, and scope of this thesis. Chapter 2 (*Literature review*) summarises previous research related to information sharing, IQ, information utilisation and OPC performance and identifies gaps in this research. Chapter 3 (*Research questions*) develops and presents three research questions and their internal relationships in relation to the identified research gaps. Chapter 4 (*Methodology*) describes how the research has been planned, executed, and presented. Chapter 5 (*Summary of appended papers*) summarises the five papers that are appended to this thesis. Chapter 6 (*Results*) provide answers to the three developed research questions separately and Chapter 7 (*Discussion*) discusses the results in relation to previous research and in relation to the overall research problem. Chapter 8 (*Concluding remarks*) concludes the results and contributions of the thesis as well as presents its limitations and ideas for future research.

2 Literature review

This chapter reviews previous research related to information sharing, IQ, information utilisation and OPC performance. In the end of the chapter, a summary of the literature review is presented, where gaps in previous research are highlighted.

2.1 Information sharing

The concept of information sharing is extensively studied in previous research, and in a supply chain context, refers to the extent to which crucial and/or proprietary information is available to members of the supply chain (Hsu et al., 2008). In previous research, information sharing is both treated as its own concept, but is also included in the wider concepts of supply chain integration (e.g. Frohlich & Westbrook, 2001; Flynn et al., 2010; Yu et al., 2013) and supply chain collaboration (e.g. Stank et al., 2001; Skjoett-Larsen et al., 2003; Holweg et al., 2005). In this section, the characteristics, determinants, and value of information sharing are presented in accordance with previous research.

2.1.1 Characteristics of information sharing

Several types of demand-related information are shared between supply chain actors. Mohr and Nevin (1990) define four facets of information sharing: content, modality, direction, and frequency. Content refers to the message of communication (Mohr & Nevin, 1990), the design of it (Jonsson, 2008) as well as its diversity (Cai et al., 2006). The message of communication in a planning environment refers to for example point-of-sales data, trends and forecasts, planned and firm customer orders, inventory levels (Jonsson & Mattsson, 2013) and demand variance (Huang et al., 2003). Of the demand-related information, most focus in previous research has been on point-of-sales data, inventory levels, and demand variance (Huang et al., 2003), while orders and forecasts are less studied. The value of the different types of shared information is conflicting in previous research, for example, Lee et al. (2000) conclude that the value of sharing point-of-sales data is quite high, while Lehtonen et al. (2005) show that point-of-sales data can be valuable in some situations and not in others, and Jonsson and Mattsson (2013) conclude that point-of-sales data is not valuable in any of their studied situations. Furthermore, Forslund and Jonsson (2007) show that the value of sharing forecast information is limited, while Jonsson and Mattsson (2013) show that forecasts and customer orders are valuable to share when demand is unstable. Moreover, Vigtil (2007) show the importance of sharing inventory levels in vendor-managed inventories, however, Cachon and Fisher (2000) show that the value is limited.

The design of information refers to the planning horizon, planning period, and planning unit of the shared information (Jonsson, 2008). The planning horizon declares the time frame the information covers (Holweg & Pil, 2008) and the planning period describe the smallest unit of time for which the information is shared, whereas the planning unit represents the aggregation level of the information (Jonsson, 2008). Although Altug and Muharremoglu (2011) argue that information sharing is especially important when information horizons are long, no other research is identified that relates the design of the information to the value of information sharing for planning purposes. Likewise, no research is identified that relates the diversity of shared information, which includes the number of distinct types of information shared (Cai et al., 2006), to the value of information sharing in planning environments.

Modality refers to the method of communication (Mohr & Nevin, 1990) and there are several different modes for sharing information in supply chains. Lösch and Lambert (2007) mention face-to-face, emails, telephone, fax, and regular mail, while Hieber (2002) add EDI, groupware systems, Internet applications, supply chain management software applications, business data

warehouses, and internal portals and Kochan et al. (2018) add cloud-based information sharing. The information mode can either be formal or informal (Narasimhan & Nair, 2005), where formal modes are regularized and structured, and informal modes are non-regularized and spontaneous (Mohr & Nevin, 1990). In previous operations management research, the value of different types of modalities is scarce, however, Jonsson and Gustavsson (2008) argue that the use of more automated and integrated information sharing modes (e.g., EDI and Internet applications) often improves the quality of the shared information.

Frequency refers to the amount and intensity of communication (Mohr & Nevin, 1990) and includes the number of information exchanges (Cai et al., 2006). The frequency can also be routinised or spontaneous, where routinised information is formalised and shared at specific time points, while spontaneous information does not have to be formalised and is shared ad-hoc (Jonsson, 2008). The frequency is also related to the permanence of the information, which declares how long the information is valid until new information is received (Holweg & Pil, 2008). The general consensus in the literature seems to be that more frequent information sharing is better than less frequent, however, few studies have actually studied this relationship.

Direction refers to the movement of communication (Mohr & Nevin, 1990), which can be either vertical, horizontal, or external (Forza & Salvador, 2001), as well as unidirectional (i.e., one-way communication) or bidirectional (i.e., two-way communication) (Holweg & Pil, 2008). In supply chains, information can be shared between several different actors, for example, between customers and retailers, between manufacturers and suppliers, or between all actors in the chain (Lumsden & Mirzabeiki, 2008). Fabbe-Costes and Jahre (2007) differ between dyadic (upstream, downstream, or both separately), triadic (upstream and downstream) or extended (more than three parties) information sharing. Several studies show that information sharing is more valuable downstream in supply chains (e.g., Lau et al., 2004; Lumsden & Mirzabeiki, 2008), however, others show the opposite (e.g., Chiang & Feng, 2007). Porterfield et al. (2010) explain this inconsistency by showing that upstream and downstream actors benefit from different types of shared information.

2.1.2 Determinants of information sharing

In previous research, several determinants of information sharing are studied (See Table 1). The determinants of information sharing can be divided into four categories: business context factors; information factors; inter-organisational factors; and intra-organisational factors. The business context factors are related to the need for shared information and is here rather seen as drivers of information sharing, than determinants of it.

The information factors include IQ (described in Chapter 2.2), network governance, information technology, traditional communication, informal communication, frequent communication, and connectivity. Lee et al. (2010) and Moberg et al. (2002) show that IQ impacts strategic information sharing, however, they are both unable to significantly show any relationship between IQ and operational information sharing. Network governance refers to coordination between organisations based on informal social systems, rather than hierarchical authority (Paulraj et al., 2008). Information technology refers to the use of information technology in any sense, e.g., the use of information systems (Dimitriadis & Koh, 2005; Kärkkäinen et al., 2007), the Internet (Kehoe & Boughton, 2001), or EDI (Tan et al., 2010) for sharing information. Traditional communication refers to communication with traditional information sharing modes (i.e., telephone, fax, email, and face-to-face contact), unlike the more advanced information technology modes, such as computer-to-computer links (Carr & Kaynak, 2007). Carr and Kaynak (2007) show that traditional communication is related to the extent of information sharing, however, advanced communication is unrelated. Informal

communication refers to the social, personal relationships between individuals (Cai et al., 2010) at different organisations. In contrast to formal communication, informal communication is less structured (Patnayakuni et al., 2006). Frequent communication refers to the intensity of information sharing (Jäckel et al., 2006) and connectivity refers to the partners' ability to connect to each other, which is enabled by information technology (Fawcett et al., 2007).

Table 1 – Determinants of information sharing.

	Business context factors	Manufacturing context	Supply chain context	Environmental context	Information need	**Information factors**	Information quality	Network governance	Information technology	Traditional communication	Informal communication	Frequent communication	Connectivity	**Inter-organisational factors**	Trust	Commitment	Interdependence	Shared vision	Participation	Willingness	Cultural similarity	Long-term relationship	**Intra-organisational factors**	Top management support	Skills and understanding	Information technology	Information management	Internal information sharing
Cagliano et al. (2006)		x																								x		
Cai et al. (2010)				x							x				x													
Carr and Kaynak (2007)										x																		x
Chen et al. (2014)															x	x		x						x		x		
Corsten et al. (2011)															x	x												
Dimitriadis and Koh (2005)									x																x	x		
Fawcett et al. (2007)													x							x								
Ha et al. (2011)															x													
Hung et al. (2011)															x	x												
Kehoe and Boughton (2001)									x																			
Kembro et al. (2017)			x				x								x			x			x				x	x		
Khouja and Kumar (2002)									x																			
Klein (2007)															x													
Klein and Rai (2009)									x						x		x											
Kärkkäinen et al. (2007)									x																			
Lee et al. (2010)			x				x								x	x	x	x			x			x				
Li and Lin (2006)				x											x			x						x				
Lu and Yang (2011)											x	x																
Maskey et al. (2020)			x	x					x		x	x			x	x					x			x				
Moberg et al. (2002)							x									x												
Müller and Gaudig (2011)			x		x				x			x															x	
Nagati and Rebolledo (2013)															x				x									
Patnayakuni et al. (2006)									x		x				x	x						x						
Paulraj et al. (2008)								x	x													x						
Roh et al. (2011)			x																									
Sheu et al. (2006)			x												x		x					x						
Stefansson (2002)									x																			
Tan et al. (2010)									x																			
Vanpoucke et al. (2009)				x					x						x		x											
Vijayasarathy (2010)		x													x	x	x											
Whipple et al. (2009)			x																									
Yigitbasioglu (2010)				x													x											
Yu et al. (2013)																												x
Zhou and Benton (2007)			x																									

The inter-organisational factors consider the supply chain relationship, and include trust, commitment, interdependence, shared visions, participation, willingness, cultural similarity, and long-term relationships. Trust refers to the sincerity, honesty, and truthfulness of information (Li & Lin, 2006; Chen et al., 2014) and also includes trust in the information sender

and its decisions (Hung et al., 2011). Commitment refers to the willingness of maintaining a long-term relationship with a collaborating partner (Hung et al., 2011; Chen et al., 2014) and the willingness of investing in the relationship (Li & Lin, 2006). Interdependence refers to the extent in which supply chain partners believe that the relationship is necessary (Lee et al., 2010) and thus to their need of maintaining the relationship (Sheu et al., 2006). Shared vision refers to the extent to which the collaborating partners have the same goals and understanding about the relationship (Li & Lin, 2006). Participation refers to the involvement and frequency of communication between collaborating partners (Jonsson & Gustavsson, 2008) and willingness refers to a company's openness to share relevant, honest, and frequent information in a supply chain (Fawcett et al., 2007). Cultural similarity refers to the extent to which the collaborating partners have similar belief, values, and management practices (Lee et al., 2010). Long-term relationship refers to the length of time for which the supply chain partners have had a relationship (Lee et al., 2010), but also the willingness to develop such a relationship for the future (Sheu et al., 2006).

The intra-organisational factors include human-, technological-, and organisational factors. Top management support and skills and understanding are human factors, where top management support refers to the top management's willingness to support the relationship with necessary resources (Chen et al., 2014) and is important both for customers and suppliers (Lee et al., 2010). Skills and understanding refer to the individual's ability to source, seek, and process information (Dimitriadis & Koh, 2005). Information technology is a technological factor and is not only important for inter-organisational information sharing, but also for intra-organisational information sharing (Dimitriadis & Koh, 2005). Information management and internal information sharing are organisational factors, where information management refers to both pruning, cleaning, and analysing data (Schnetzler & Schönsleben, 2007; Jonsson & Gustavsson, 2008), and internal information sharing refers to information sharing performed within an organisation (Carr & Kaynak, 2007), in contrast to between organisations in a supply chain.

2.1.3 Value of information sharing

Numerous researchers argue for the benefits with information sharing between supply chain actors. Many researchers have tested and shown a positive relationship between information sharing and performance (e.g., Yu et al., 2001; Ramayah & Omar, 2010; Laosirihongthong et al., 2011; Sanders et al., 2012; Şahin & Topal, 2019; Alzoubi & Yanamandra, 2020), both for customers and suppliers (Paulraj et al., 2008). Information sharing can increase the performance of many different supply chain processes, e.g., purchasing (Cai et al., 2006), forecasting (Babai et al., 2013), logistics (Ha et al., 2011; Prajogo & Olhager, 2012), and delivery processes (Li et al., 2005; He et al., 2017), by improving decision-making (Lee & Whang, 2000; Sahin & Robinson, 2002) and learning (Huo et al., 2021) in these processes. In a planning environment, information sharing can both reduce the need for inventory (Simatupang & Sridharan, 2005; Wu & Cheng, 2008), as well as improve customer satisfaction (Rollins et al., 2011; Bastl et al., 2012), by mitigating the bullwhip effect (Wikner et al., 1991; Chatfield et al., 2004; Cannella & Ciancimino, 2010; Ma et al., 2013) and reducing supply chain uncertainty (Jayaraman et al., 2008; Datta & Christopher, 2011; Hung et al., 2011).

Even though many researchers argue for the benefits with information sharing, the conclusions regarding its actual value are neither clear nor consistent (Ketzenberg et al., 2007; Jonsson & Mattsson, 2013). Several researchers are unable to confirm a relationship between information sharing and performance (e.g. Krause et al., 2007; Field & Meile, 2008; Tan et al., 2010; Liu et al., 2013). Fabbe-Costes and Jahre (2008), as well as Chan and Chan (2009), argue that full information sharing is not necessarily better than partial information sharing. Youngdahl et al.

(2003) are also unable to show a relationship between information sharing and customer satisfaction. Furthermore, both Taylor (2000) and Fawcett et al. (2009) explain that the potential benefits with information sharing seem to be difficult to reach in practice.

Several researchers argue for different situations when information sharing is especially valuable. Cachon and Fisher (2000) explain that information sharing is more important when demand is unpredictable and Lehtonen et al. (2005) mention product introductions and promotions as situations when information sharing is valuable. Furthermore, Lee et al. (2000) conclude that information sharing is more valuable when lead times are long and Welker et al. (2008) add that it is also important in other complex business contexts. Jonsson and Mattsson (2013) argue that one reason for the inconsistency and unclearness of the conclusions regarding the value of information sharing is because the value depends on the type of information shared. For example, Dwaikat et al. (2018) argue that sharing of forecast information improve supplier delivery flexibility, while sharing of inventory data do not.

2.2 Information quality

IQ is defined as the ability to satisfy stated and implied needs of an information user (Gustavsson & Wänström, 2009), i.e., a supplier receiving shared demand-related information from a customer. This section reviews previous research related to the characteristics, determinants, and value of IQ.

2.2.1 Characteristics of information quality

IQ is a multidimensional concept (Wang et al., 1996; Lee et al., 2002; Gustavsson & Wänström, 2009), with several internally-related dimensions (Fisher et al., 2012), however, there is no specific set of dimensions always included in the concept. Instead, researchers include different IQ dimensions in their IQ-related research and they also use different terms to describe these dimensions. A few IQ dimensions, e.g., timely, reliable, complete, relevant, and accessible, are covered in most IQ-related research, however, other dimensions, e.g., concise, consistent, valid, secure, credible, understandable, ease of operation, appropriate amount, and objective, are less commonly covered. Traditionally, reliability has often been the only IQ dimension in focus (Wang et al., 1996), and even though most researchers now include more dimensions, far from all IQ dimensions are covered in IQ-related research.

The division of stated and implied needs in the definition of IQ reflects the division of inherent and pragmatic IQ dimensions (English, 1999). Inherent IQ dimensions describe information in relation to stated restrictions, policies, and procedures (e.g., written agreements), while pragmatic IQ dimensions describe information in relation to implied needs by the information user (Gustavsson & Wänström, 2009). Both inherent and pragmatic dimensions are assessed by the information user, where inherent dimensions are objectively measured in relation to the stated requirements, while pragmatic dimensions are subjectively judged by the user. There is no distinct division between inherent and pragmatic IQ dimensions (Gustavsson & Wänström, 2009), however, Lee et al. (2002) include timely, reliable, complete, concise, consistent, and secure, as inherent dimensions; and relevant, accessible, credible, understandable, ease of operation, appropriate amount, objective, and valid, as pragmatic dimensions. Similarly, Gustavsson and Wänström (2009) indicate that timely, reliable, complete, concise, and valid are inherent dimensions; and relevant, accessible, credible, understandable, and appropriate amount are pragmatic dimensions. The only distinction between the two divisions is that Lee et al. (2002) include the valid dimension as pragmatic, while Gustavsson and Wänström (2009) include it as an inherent dimension. The reason for this distinction is that Lee et al. (2002) use the dimension in wider terms and relate it both to the validity and the undertandability of

information. As understandability is a pragmatic dimension, validity is here described as inherent.

The inherent dimensions are objectively measured in relation to stated requirements (e.g., written agreements). Timeliness refers to the age of the data (Wang et al., 1996), i.e., how current and up-to-date it is (Lee et al., 2002). The information also needs to be delivered on time and at correct intervals (Gustavsson & Wänström, 2009) to be considered timely. Reliability refers to how correct, accurate, free of error (Lee et al., 2002), flawless, precise (Wang et al., 1996), and sound (Bruch & Bellgran, 2013) information is. Reliable demand information reflects true demand and has low forecast errors (Gustavsson & Jonsson, 2008). Completeness refers to the extent to which the information is comprehensive for the planning tasks (Gustavsson & Wänström, 2009), both in terms of breadth, depth (Lee et al., 2002), and scope (Wang et al., 1996). Complete information includes all necessary values, and explanation of values, needed to perform a task (Gustavsson & Jonsson, 2008). Conciseness refers to how well-presented, well-organised (Wang et al., 1996), and compact (Lee et al., 2002) information is. Concise information can be used directly, without any reworking of format, content, or structure (Gustavsson & Wänström, 2009). Consistency refers to the data continuously being presented in the same format (Lee et al., 2002) and being compatible with previous data (Wang et al., 1996). The information needs to be presented in a reliable structure (Bruch & Bellgran, 2013) to be consistent. Validity refers to the extent to which the information measures what it should measure (Gustavsson & Wänström, 2009). The customer needs to use the same measures and definitions as the supplier (Gustavsson & Jonsson, 2008) and the information needs to be interpretable, in terms of languages, symbols, and units (Johansson & Johansson, 2004) in order to be valid. Security refers to how restricted the access to the information is. For information to be secure, it can only be assessed by people who should see the information (Lee et al., 2002), as secure information relates to data of proprietary nature (Wang et al., 1996).

The pragmatic dimensions are subjectively judged by the information user, and the user itself can also impact these dimensions. Relevance refers to how relevant, value-adding, and adequate information is (Wang et al., 1996; Li et al., 2005; Claassen et al., 2008) for the task of the information user (Gustavsson & Jonsson, 2008; Gustavsson & Wänström, 2009). It is related to the usefulness and usability of information (Wang et al., 1996; Lee et al., 2002), and information needs to be presented on an appropriate level of detail (Goodhue & Thompson, 1995) to be relevant. Accessibility refers to how easy it is to access, obtain, and retrieve information when needed by the information user (Lee et al., 2002; Gustavsson & Jonsson, 2008; Gustavsson & Wänström, 2009), without further processing (Forslund & Jonsson, 2007). Information needs to be both easy to locate (Goodhue & Thompson, 1995) and quickly available (Wang et al., 1996; Lee et al., 2002) to be accessible. Credibility refers to how credible, believable, and trustworthy information is for the information user (Lee et al., 2002; Gustavsson & Jonsson, 2008; Jonsson & Gustavsson, 2008). It is also related to the reputation of the information, both in terms of actual data and the data source (Wang et al., 1996; Lee et al., 2002). Information needs to be regarded as true (Gustavsson & Wänström, 2009) to be credible. Understandability refers to how easy it is for the information user to comprehend the information (Lee et al., 2002). Gustavsson and Wänström (2009) also relate understandability to how easy it is to use the information, which here is included in the ease of operation dimension. Information needs to be both readable and clear (Wang et al., 1996) to be understandable. Ease of operation refers to how easy it is to aggregate, combine, and manipulate the information to meet the needs of the information user (Lee et al., 2002). It is related to how easy it is to process the information (Manecke & Schoensleben, 2004) and information needs to be easy to update, reproduce, and integrate (Wang et al., 1996) to be easy to operate.

Appropriate amount refers to the volume of information, which should neither be too much or too little in relation to the needs of the information user (Lee et al., 2002). It is related to how much filtration is necessary before the information user can utilise the information (Gustavsson & Wänström, 2009). Objectivity refers to how objective and unbiased information is (Wang et al., 1996) and requires the information to be both objectively collected and presented (Lee et al., 2002).

2.2.2 Determinants of information quality

In previous research, some determinants of IQ are studied (see Table 2), however, most determinants are only covered by a few researchers. Only trust (e.g., Hung et al., 2011; Chen et al., 2014), information technology (e.g., Auramo et al., 2005; Kärkkäinen et al., 2007), and information management (e.g., Schnetzler & Schönsleben, 2007; Gustavsson & Jonsson, 2008) are studied in any larger extent. Also, most determinants of IQ are discussed on an overall quality level (i.e., in relation to a combination of IQ dimensions) and only a few researchers (e.g., Johansson & Johansson, 2004; Jonsson & Gustavsson, 2008) study the determinants in relation to specific IQ dimensions. The determinants of IQ can be categorised into four categories (the same as the determinants of information sharing): business context factors; information factors; inter-organisational factors; and intra-organisational factors. The business context factors are related to the need for shared information of high quality and are rather seen as drivers for IQ, than determinants of it (similar as with information sharing in Chapter 2.1.3).

Table 2 - Determinants of information quality.

	Business context factors	Supply chain context	Information need	**Information factors**	Information technology	Informal communication	Frequent communication	Feedback	**Inter-organisational**	Trust	Commitment	Shared vision	Participation	Cultural similarity	**Intra-organisational**	Top management support	Skills and understanding	Information technology	Information management
Auramo et al. (2005)					x														
Barratt and Oke (2007)					x	x				x	x								
Chen et al. (2014)										x	x	x				x		x	
Gustavsson and Jonsson (2008)			x				x											x	x
Hazen et al. (2014a)																			x
Hung et al. (2011)										x	x								
Ivert (2012)			x					x											
Johansson and Johansson (2004)																		x	
Jonsson and Gustavsson (2008)					x		x			x			x					x	x
Jäckel et al. (2006)							x	x									x		
Kärkkäinen et al. (2007)					x														
Li and Lin (2006)		x								x		x							
Lu and Yang (2011)										x		x	x	x					
Manecke and Schoensleben (2004)					x														
Min (2009)																			x
Schnetzler and Schönsleben (2007)																			x
Zaheer and Trkman (2017)					x					x	x		x						

The information factors are defined in the same way as they were as determinants of information sharing. Jonsson and Gustavsson (2008) empirically show a relationship between information technology and some inherent IQ dimensions and Auramo et al. (2005) show a relationship between information technology and reliability of shared information, however, Li

and Lin (2006) were unable to significantly show any relationship between information technology and overall IQ. Furthermore, the informality of information is only studied on an overall IQ level (Barratt & Oke, 2007), but the frequency of communication is related to the completeness, conciseness, reliability, timeliness, and credibility of information (Jonsson & Gustavsson, 2008). Gustavsson and Jonsson (2008) also show that high information sharing frequency is positively related to IQ for orders but negatively related for forecasts. Feedback is the only information factor not included as a determinant of information sharing, and refers to the reverse flow of information (Jäckel et al., 2006) and is only studied in relation to the reliability of information (Ivert, 2012).

The inter-organisational factors consider supply chain relationship and are defined in the same way as determinants of information sharing. In previous research, trust is related to previous information reliability (Chen et al., 2014) and is specifically important for the complete, concise, reliable, timely, and credible IQ dimensions (Jonsson & Gustavsson, 2008). Commitment is only studied on an overall IQ level in previous research, with conflicting results. While e.g., Hung et al. (2011) show a positive impact of commitment on IQ, Li and Lin (2006) were unable to significantly show this impact. Further, shared vision is only studied in relation to overall IQ, and here Li and Lin (2006) are able to show a positive impact. Participation is studied by Jonsson and Gustavsson (2008), who show a direct relationship to the valid and credible IQ dimensions. Cultural similarity is only studied by Lu and Yang (2011), who studied it on an overall IQ level.

The intra-organisational factors are divided and defined in the same way as determinants of information sharing. Top management support (Chen et al., 2014) and skills and understanding (Jäckel et al., 2006) are only studied in relation to overall IQ in previous research. Jonsson and Gustavsson (2008) study automatic data communication and registration as important for complete, concise, reliable, timely, and valid IQ dimensions, and Johansson and Johansson (2004) discuss information technology in relation to accessibility, ease of operation, and timeliness. Also, information life-cycle management is shown to be important for complete, timely, and valid IQ dimensions (Jonsson & Gustavsson, 2008).

2.2.3 Value of information quality

The importance of IQ is highlighted in previous research and it has been shown to impact a large number of different processes and systems, e.g., planning processes (Petersen et al., 2005; Gustavsson & Jonsson, 2008), forecasting processes (Eksoz et al., 2014), information management processes (Schnetzler & Schönsleben, 2007), delivery processes, (Li et al., 2005), warehousing systems (Min, 2009), and APS systems (Ivert, 2012). High IQ improves performance (Bartlett et al., 2007; Hartono et al., 2010; Wiengarten et al., 2010; Zhou et al., 2014; Ji-fan Ren et al., 2017), by increasing the utilisation of shared information (Bruch & Bellgran, 2013) and information systems (Hazen et al., 2014b), and thereby improves decision-making (Hazen et al., 2014a) in these processes. In a planning environment, high IQ can reduce inventories and backlogs (Rossin, 2007; Claudio & Krishnamurthy, 2009), by mitigating the bullwhip effect (Chatfield et al., 2004; Chatfield, 2013) and reducing supply chain uncertainty (Holweg et al., 2011; Hung et al., 2011). Furthermore, high IQ increases the intensity of information sharing (Baihaqi & Sohal, 2013) between supply chain actors. However, the relationship between IQ and performance is not indisputable. Forslund and Jonsson (2007) are unable to significantly show a relationship between forecast IQ and supply chain performance, and Claassen et al. (2008) are unable to show a relationship between IQ and VMI success.

2.3 Information utilisation

Very few identified papers explicitly study information utilisation and there is no clear definition of the concept. Although Kiil et al. (2019) define it as the inclusion of received information, the utilisation of shared information is often presumed in previous research. This section reviews previous research related to the characteristics, determinants and value of information utilisation.

2.3.1 Characteristics of information utilisation

As only a few identified papers explicitly study information utilisation, it is not clear what it actually entails. Sener et al. (2019) study the utilisation of a combination of several types of shared information in the food industry, however, they do not distinguish between the different types of information. Also, they argue that it is important to separate information sharing from information utilisation, but it is not clear how to do so. Several other researchers also implicitly discuss information utilisation, by including utilisation related items when studying information sharing and/or IQ. Paulraj et al. (2008) and Lee et al. (2010), among others, include information usefulness when studying information sharing, which should be related to information utilisation. Furthermore, studies on IQ (e.g., Li & Lin, 2006; Jonsson & Gustavsson, 2008) include specific IQ dimensions that assesses the ease of use and usefulness of shared information. Fawcett et al. (2007) explain that potentially useful information does not improve decision-making if the information is unavailable, which also indicates that both usefulness and ease of use are important aspects of information utilisation.

2.3.2 Determinants of information utilisation

Only one determinant of information utilisation is identified in previous research, namely IQ. Moorman et al. (1992) conclude that IQ determines in what extent market research information is utilised. Also, Bruch and Bellgran (2013) argue that higher IQ increases the likeliness of information utilisation, and Lee et al. (2010) state that supply chain information will not be utilised if there is a lack of confidence in IQ. Furthermore, Lee and Whang (2000) argue that companies must develop capabilities for utilising shared information in an effective way, however, they do not specifically discuss different capabilities.

2.3.3 Value of information utilisation

Even though it is not commonly studied in explicit terms in previous research, it is obvious that research studying the linkage between information sharing or IQ and performance (e.g. Yu et al., 2001; Bartlett et al., 2007; Paulraj et al., 2008; Wiengarten et al., 2010; Sanders et al., 2012; Şahin & Topal, 2019) implicitly presume information utilisation. Also, Sener et al. (2019) empirically conclude that information utilisation has a mediating effect between information sharing and operational performance. Furthermore, a few researchers explicitly argue for the importance of information utilisation, however, their actual relevant studies of it are limited. For example, Tokar et al. (2011) explain that information sharing alone does not improve performance, but that the information also needs to be utilised. Bendoly et al. (2009) discuss a relationship between information utilisation and profitability, and Wikner et al. (1991) argue that better utilisation of information flow reduces demand amplifications. Furthermore, Rota et al. (2002) state that information utilisation is important in order to balance supply and demand. Davis et al. (2011) argue that both retailers and suppliers can benefit from information utilisation, and Robinson et al. (1995) explain the benefits of using both upstream and downstream information. Also, both Weber and Kantamneni (2002) and Dreyer et al. (2009) argue that information utilisation is crucial for staying competitive in today's business environment. Still, none of these researchers explicitly study information utilisation.

2.4 Operations planning and control performance

The OPC processes are performed on operational, tactical, and strategic planning levels (Jonsson & Mattsson, 2009; Jacobs et al., 2011), which range from short-term to long-term planning (Stadtler, 2005). The planning processes have different objectives and are thus based on different types of demand-related information. Operational planning deals with order planning, transport planning, material planning, and demand fulfilment (Huang et al., 2003; Stadtler, 2005) and is based on order information, production schedules, delivery schedules, inventory levels, shipments, lead times, and shipping notices (Moberg et al., 2002; Li et al., 2006; Patnayakuni et al., 2006; Rai et al., 2006). Tactical planning deals with master planning, production planning, distribution planning, and demand planning (Huang et al., 2003; Stadtler, 2005) and is based on forecasts, performance metrics, and purchasing and logistics information (Patnayakuni et al., 2006; Rai et al., 2006; Hsu et al., 2008). Strategic planning deals with strategic network planning and facility planning (Huang et al., 2003; Stadtler, 2005) and is based on pricing strategies, marketing strategies, distribution strategies, product development information, market trends, point-of-sales data, and long-term forecasts (Moberg et al., 2002; Li et al., 2006; Patnayakuni et al., 2006; Rai et al., 2006).

Although the different planning processes have individual objectives, their mutual objective is to support the decision of when, what, and how much to produce, to balance supply and demand (Jonsson & Mattsson, 2009; Jacobs et al., 2011). This is the mutual objective considered when assessing the performance of the OPC processes. However, for the OPC processes to be considered successful, it is not enough that there is a balance between supply and demand; the resources needed to achieve this balance is also important (Slack et al., 2010). A common mean of assuring a balance between supply and demand is using additional inventory (Jonsson & Mattsson, 2009; Jacobs et al., 2011), however, as this is costly, it has a negative impact on OPC performance. When assessing OPC performance, Forslund and Jonsson (2007) thus include both the output of the processes, in terms of customer service, as well as the resources used in the processes, in terms of preventive and reactive actions needed in the processes.

2.5 Summary of the literature review

The literature describes that information sharing is characterised by the content, modality, frequency, and direction of communication, which can be combined into several distinctly different information sharing objects. It is clear from the literature that different types of demand-related information are important in different OPC processes and numerous researchers have assessed the extent of these information types in practice. The literature also describes that IQ is characterised by a set of inherent and pragmatic IQ dimensions, which are related to the ease of use and usefulness of information. It is indicated that different IQ dimensions are important for different types of information and previous research has assessed IQ for at least some of these information types in practice. Moreover, the literature describes that OPC performance is characterised by the output of the processes as well as by the resources needed in the processes and previous research has assessed these aspects of the OPC processes in practice. To the contrary, it is not clear from the literature how information utilisation is characterised, and it is not assessed how shared demand-related information is utilised by suppliers in practice.

The literature identifies several inter- and intra-organisational determinants of information sharing and overall IQ, however, it does not completely explain how these determinants impact specific IQ dimensions. Furthermore, no inter- and intra-organisational determinants of information utilisation is identified in the literature. Also, the literature indicates the relationships between information sharing, IQ, information utilisation and OPC performance,

however, the conclusions regarding these relationships are unclear and inconsistent in previous research. Most previous research concerning the relationship between information sharing and performance does not include the mediators and the same is true for the relationship between IQ and performance. By excluding the mediators in these relationships, the literature fails to explain how certain information factors impact specific IQ dimensions, how perceived IQ impacts information utilisation, and how information utilisation impacts OPC performance. A summary of the literature review is illustrated in Figure 2, where it is apparent what is covered in previous research and what is not.

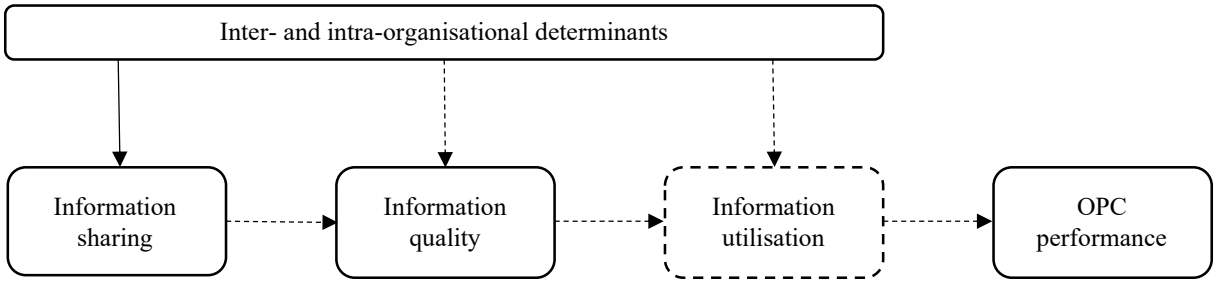

Figure 2 – Summary of the literature review (solid lines are extensively studied in previous research and dotted lines are limited in previous research).

3 Research questions

This chapter relates the purpose of the thesis to the gaps identified in previous research. Relevant research areas are identified and motivated, which ends up in three research questions. In the end of the chapter, an explanation for how the three research questions are related to each other and to previous research, is presented.

3.1 Development of research questions

The purpose of the thesis is to provide knowledge about the role of information utilisation in a supplier's operations planning and control processes, for generating value of shared demand-related information in automotive supply chains. To do so, it is first necessary to understand the current state of information utilisation in the automotive industry (i.e., how suppliers utilise shared demand-related information in their OPC processes). Then, it becomes important to understand why the suppliers utilise the shared information as they do (i.e., how different determinants impact information utilisation) and the effect of the utilisation (i.e., the mediating role between information sharing and performance).

It is apparent from the literature review that no identified study has assessed the extent of information utilisation of shared demand-related information in practice, neither in the automotive industry nor elsewhere. It is not even clear from the literature how to assess information utilisation in practice. Still, it is important to understand the current state of information utilisation in the automotive industry, both for academia and for the industry. For academia, it is important as many researchers previously have implicitly presumed that shared information is utilised by the information receiver (see e.g., Yu et al., 2001; Bartlett et al., 2007; Paulraj et al., 2008; Wiengarten et al., 2010; Sanders et al., 2012; Şahin & Topal, 2019) and an assessment of the current state would determine if it is justifiable to continue with this presumption. For the industry, it is important as many OEMs share large amounts of demand-related information with their suppliers, without knowing how the information is utilised. An assessment of how suppliers in the automotive industry utilise shared demand-related information in their OPC processes would provide feedback on the information sharing strategies used by the OEMs. It would also provide input to the possibilities for OEMs to differentiate its information sharing strategies, if it turns out that different types of suppliers utilise shared demand-related information in different ways. The first research question (RQ) of this thesis is thus formulated as:

RQ1: How do suppliers in the automotive industry utilise shared demand-related information in their operations planning and control processes?

The only determinant of information utilisation identified in previous research is IQ (Moorman et al., 1992), however, Bruch and Bellgran (2013) argue that higher IQ increases the likeliness of information utilisation, indicating that IQ is not the only determinant of utilisation. Furthermore, Lee and Whang (2000) argue that companies must develop capabilities for effectively utilising shared information, also indicating that more than one determinant exists. The literature review identifies several determinants of information sharing and IQ and some of the studies include information utilisation-related items in the information sharing and IQ constructs (e.g., Jonsson & Gustavsson, 2008; Paulraj et al., 2008; Chen et al., 2014). This indicates that the three concepts are interrelated and that some of the determinants of information sharing and IQ can also be direct determinants of information utilisation. For example, as production planners have influence on the OPC processes (Berglund & Guinery, 2008), their skills and understanding to process information (Dimitriadis & Koh, 2005) should likely impact how shared information is interpreted and utilised in the processes. Furthermore,

as both internal and external IT is important for information sharing and IQ (Dimitriadis & Koh, 2005; Jonsson & Gustavsson, 2008) and the functionality of the internal planning system determines how planning is performed (Ivert & Jonsson, 2011), the functionality of the system should likely also impact how shared demand-related information is utilised. Thus, despite not explicitly studied in previous research, some inter- and intra-organisational factors should have direct determinantal impact on information utilisation.

As IQ is considered a determinant of information utilisation (Moorman et al., 1992), the inter- and intra-organisational determinants of IQ identified in previous research also indirectly impact information utilisation. Even though several determinants of IQ already are studied in previous research, the IQ-related research explicitly studying demand-related information (e.g., Forslund & Jonsson, 2007; Gustavsson & Jonsson, 2008; Jonsson & Gustavsson, 2008) does not fully explain how demand-related IQ deficiencies occur. Furthermore, only a few researchers (Johansson & Johansson, 2004; Jonsson & Gustavsson, 2008) study determinants of specific IQ dimensions, and they do not provide a complete picture of how the determinants impact specific IQ dimensions. Still, because of the multi-dimensionality of the IQ concept (Wang et al., 1996; Lee et al., 2002; Gustavsson & Wänström, 2009), it is necessary to separate specific IQ dimensions to fully understand how the determinants impact IQ, and thereby indirectly the utilisation of shared demand-related information. With the same logic, also the determinants of information sharing also indirectly impact the utilisation of shared demand-related information, however, as these determinants already are excessively studied in previous research, they are not considered important to study further here.

The understanding of how inter- and intra-organisational determinants, both directly and indirectly through IQ, impact how a supplier utilises shared demand-related information in its OPC processes is important for both academia and for industry. For academia, such understanding helps to explain the previously conflicting results regarding the value of information sharing and IQ, and for industry, it highlights the determinantal areas to focus on in the endeavour to increase the utilisation of shared demand-related information. A second research question for this thesis is thus formulated as:

RQ2: How do inter- and intra-organisational determinants impact how automotive industry suppliers utilise shared demand-related information in their operations planning and control processes, both (a) directly and (b) indirectly, through information quality?

Even though a few researchers explicitly argue for the importance of information utilisation (e.g., Rota et al., 2002; Bendoly et al., 2009; Tokar et al., 2011), none of them actually study its performance effect. Furthermore, despite the fact that IQ is pointed out as a determinant of information utilisation (Moorman et al., 1992) and it is implied that information utilisation mediates the relationship between IQ and performance (e.g., Bartlett et al., 2007; Hartono et al., 2010; Wiengarten et al., 2010; Zhou et al., 2014; Ji-fan Ren et al., 2017), it is not clear how the mediation differs between different types of shared demand-related information. As different planning processes are based on different types of demand-related information, there should be differences in how information utilisation mediates the relationships between IQ and OPC performance for different types of shared information. For example, order information is expected to be highly utilised by suppliers in the automotive industry, regardless of its quality, since the orders determine when deliveries should occur, while other types of information, where alternative internal information exist, might be disregarded if it is not of high quality. The understanding of how information utilisation mediates the relationship between IQ and OPC performance for different types of shared demand-related information is important for

both academia and for industry. For academia, such understanding helps to further explain the previously conflicting results regarding the value of information sharing and IQ, and for industry, it clarifies the performance effect of the utilisation of different types of shared demand-related information. A third and last research question for this thesis is thus formulated as:

RQ3: How does information utilisation mediate the relationship between information quality and operations planning and control performance for different types of demand-related information shared in the automotive industry?

3.2 Relationships between research questions and previous research

Figure 3 below is an illustration of how the three research questions are related to each other, as well as to the gaps identified in previous research. RQ1 assesses the extent of information utilisation at automotive industry suppliers in practice. RQ2 explores and validates the direct and indirect inter- and intra-organisational determinants of information utilisation and RQ3 tests how information utilisation mediates the relationships between IQ and OPC performance for different types of shared demand-related information.

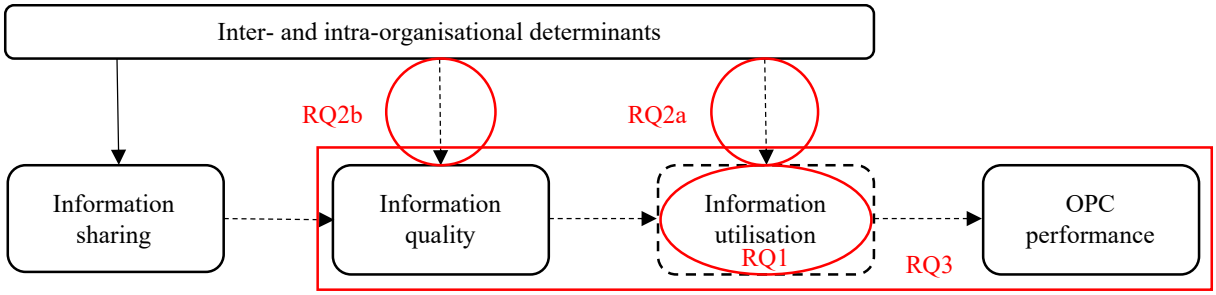

Figure 3 - Positioning of RQs.

4 Methodology

This chapter describes the overall research process, the research design, case and sample selections, data collection and analyses, and research quality. The chapter ends with a description of how the research results are presented.

4.1 Research process

The research process started in February 2011. In the beginning of the process, the scope of the research was not clearly defined, and the initial time was spent on scanning previous research and setting the scope of the research. During this time, a pre-study was also performed, which enabled the author to gain a practical understanding of potential research problems. After one year, a research proposal was presented. During 2012, the first study was designed and executed. The design of the second study was also performed during 2012 and the data collection of the second study was performed during 2012 and 2013. Preliminary data analysis of the second study was performed during 2013. Due to parental leave, the research was paused during 2014, but picked up again during 2015. The second study was finalised in the beginning of 2015. During 2015, the first two studies were also brought together, and a licentiate thesis was presented. Due to another parental leave, the research was again paused for one year until mid 2016. After that, until the end, the research was conducted part time. The design of the third study was performed from mid 2016 until the beginning of 2018. Data for the third study was mainly collected during 2018 but complementary data was also collected during 2019 and 2020. The data analysis was performed during 2019 and finalized in 2020. During 2020 and 2021, the three studies were also brought together, and summarised in this doctoral thesis.

During 2012-2014, the research was part of a larger research project called: Managing production and supply networks in turbulent environments; in which information sharing and utilisation are important parts. The research project was funded by the Swedish Governmental Agency for Innovation Systems (VINNOVA). Two project conferences were held within the project, providing feedback on the research. From 2018, the research was part of another larger research project called: Future of sharing schedule information in automotive industry supply chains using advanced data analytics, which is directly linked to information sharing and utilisation. This project was funded by The Strategic Vehicle Research and Innovation Programme (FFI). Within this project, the research was continuously discussed with all research partners, who provided feedback on the research.

4.2 Research design

Both Flick (2009) and Bryman and Bell (2011) argue that the research questions are the starting point of the research process, and should guide the decisions about the research design, case and sample selection, data collection, data analysis, and presentation of results. Maxwell (2005) provides a slightly different approach to research design and argues that the research questions do not have to be the starting point. Instead, he argues that it is an iterative process. Still, Maxwell (2005) agrees that there has to be a fit between the research questions and the other aspects of the research design. Thus, the research design used in this research needs to match the three research questions formulated in Section 3.1.

The three research questions formulated in this thesis are of different nature and thus require different research designs. The first research question is mainly of a descriptive nature (as defined by Marshall & Rossman, 2014) as it requires a description of the current status of information utilisation in the automotive industry. Descriptive research aims at describing the incidence of a phenomenon, and thus requires a substantial amount of data (Forza, 2009). The data also needs to be quantitative when the aim is to perform statistical comparisons between

different groups of respondents, in this case suppliers. Filippini (1997) shows that survey studies traditionally have been used for descriptive purposes in operations management research and that is not surprising, as survey studies are especially suitable when large amounts of quantitative data is required (Blair et al., 2013).

The second research question is mainly of an exploratory nature (as defined by Marshall & Rossman, 2014) as it requires exploration of information utilisation determinants. Exploratory research aims at exploring a phenomenon that is little understood in previous research (Marshall & Rossman, 2014), which is true for determinants of information utilisation. The focus on understanding makes a qualitative research approach appropriate (Maxwell, 2005), where case studies are particularly suitable (Yin, 2009) as it enables a deeper understanding than most other approaches. Qualitative case studies are appropriate when there is a lack of previous research (Eisenhardt, 1989), as it is here, and when the aim is to construct, adapt, extend, and refine theories (Dubois & Araujo, 2007), rather than testing them. However, by combining a qualitative case study with a quantitative survey study, the results from a case study can be confirmed and validated (Saunders, 2011).

The third research question is mainly of an explanatory nature (as defined by Marshall & Rossman, 2014) as it requires explanations of relationships between different variables. Explanatory research aims at explaining relationships shaping a phenomenon (Marshall & Rossman, 2014) and as explanatory research tests existing theories or models, rather than developing them, this type of research is dependent on quantitative data (Bryman & Bell, 2011). One common approach for explanatory research in operations management are confirmatory survey studies, which are appropriate as the large amounts of data enabled by survey studies allow for generalization of the tested theory or model (Forza, 2009). Another approach for explanatory research is experiments, but this approach is often difficult to perform in most business research (Bryman & Bell, 2011), which also is true here. However, to understand the mechanism behind the studied relationships, it is preferable to combine the survey study with a qualitative case study (Forza, 2009).

The thesis is based on two separate case studies, Case study 1 and Case study 2, as well as one Survey study. The two case studies are performed in succeeding order and the Survey study is performed after both case studies. Case study 1 is designed to get a deeper understanding of the relationships between information sharing, IQ, information utilisation and performance, while Case study 2 is designed to get a deeper understanding of the inter- and intra-organisational determinants of IQ and information utilisation. The Survey study is designed to describe how information is utilised by suppliers in the automotive industry as well as to test hypotheses developed from the findings in Case study 1 and 2. How the three studies are related to the three research questions are illustrated in Figure 4 below.

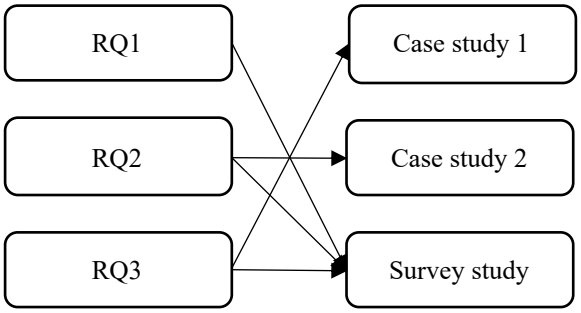

Figure 4 - Relationships between studies and research questions.

4.3 Case and sample selection

All studies included in this thesis are performed in the automotive industry. Case study 1 is performed in a supply network, including one OEM and one of its suppliers. The studied supplier acts as both a first-, second-, and third-tier supplier to the OEM, depending on the products delivered. Except for the OEM and the supplier, the case study also includes three intermediate companies in the supply network (called tier 1, tier 2a, and tier 2b). The case was selected according to maximum variation sampling (as described by Flick, 2009), as the aim was to include companies in different tiers of the supply chain. By studying a supply network instead of unrelated suppliers in different tiers, it not only enabled the identification of different IQ deficiencies in different tiers, but it also enabled a determination of the actual consequences of the deficiencies, as they impact the same planning processes. Also, the different customers in the network have different relationships with the supplier, which enabled the identification of a rich variety of IQ deficiencies. The relationships between the OEM, the supplier, tier 1, tier 2a, and tier 2b are illustrated in Figure 5.

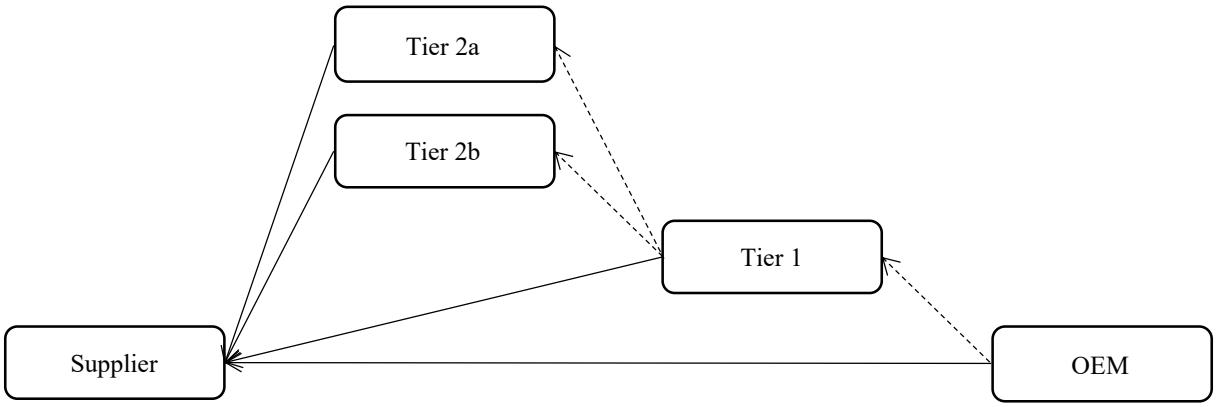

Figure 5 - Companies in Case study 1 (solid lines show shared demand-related information in focus and dotted lines show shared demand-related information not in focus).

Case study 2 includes one OEM and three of its first-tier suppliers. None of the studied companies in Case study 2 are the same as the companies in Case study 1, meaning a total of nine case companies are included in the thesis. The OEM was selected first, because it shares several different types of demand-related information with its suppliers. The suppliers were selected, together with the OEM, according to maximum variation sampling and convenience sampling (as described by Flick, 2009). It was stated that the suppliers should differ in type of products, manufacturing strategy, delivery pattern, firm size, organisational complexity, planning processes, and relationship with the OEM, however, for convenience reasons no long-distance supplier was included, even though it would have increased the variation further. The relationships between the OEM and the three suppliers are illustrated in Figure 6.

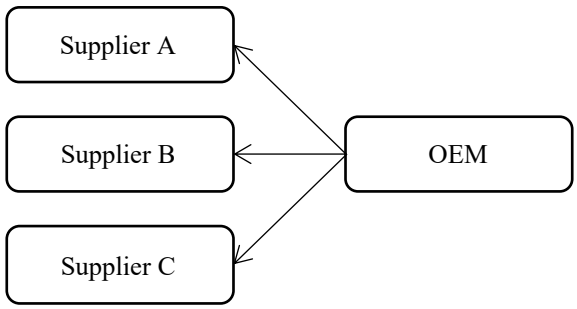

Figure 6 - Companies in Case study 2 (lines show shared demand-related information in focus).

The Survey study includes three OEMs, where two are the same OEMs as in Case study 1 and 2, and all of their first-tier manufacturing suppliers. The three OEM's were selected as they are the three main automotive manufacturers in Sweden, and as the survey design enabled data collection from numerous suppliers, no specific data collection sample was selected. Instead, an invitation to participate in the survey was sent to all of the 2 527 unique suppliers that the OEMs provided email addresses to. The companies included in the Survey study are illustrated in Figure 7.

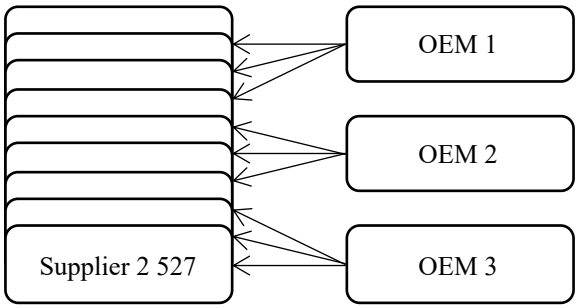

Figure 7 – Companies in the Survey study (lines show shared demand-related information in focus).

4.4 Data collection

The main data collection technique used in both case studies are semi-structure interviews (as described by Flick, 2009). The openness of the interview questions allowed the researchers to explore the studied phenomena, seen through the eyes of the interviewees (for interview guide, see Appendix A). Complementary to the interview data in the case studies, also observations of the OPC processes in focus, as well as the information utilisation in the processes, internal documents, and reviews of the shared information in focus were collected. In Case study 1, reviews of the delivery schedules were of a quantitative nature. Furthermore, in Case study 2, a small survey was used to validate the interview data regarding the interviewees' perception of the IQ of the shared information (for survey design, see Appendix B). The data collection performed in all three studies are summarised in Table 3.

Table 3 - Data collection in the three studies.

	Case study 1	**Case study 2**	**Survey study**
Semi-structured interviews	5 interviews, 3 interviewees	27 interviews, 22 interviewees	-
Observations	Production scheduling process Information utilisation	Forecasting process Production planning process MPS process Materials planning process Order delivery process Information utilisation	-
Internal documents	Data analysis documents	Process descriptions	-
Reviews of shared information	Delivery schedules	Delivery schedules Production programs Webcasts Online planning system	-
Workshops	Group discussions with OEM and supplier	Group discussions with OEMs	Group discussions with OEMs and suppliers
Survey	-	16 respondents	253 respondents

In the Survey study, invitations to participate in an online survey were sent to 2 527 unique suppliers, where 1 984 of them turned out to be usable addresses (for survey design, see

Appendix B). After several remainders, 253 responses were received, which corresponds to a response rate of 12.7%. This response rate goes well in line with Larson (2005), who reports that a response rate around 10% is common for electronic surveys within this subject. It also goes in line with other, more recent studies within the field (e.g., Yusuf et al., 2014; Narayanan et al., 2015; Kalaitzi et al., 2019), who report response rates between 6-14%.

4.5 Data analyses

One of the main difficulties with qualitative research is the data analysis, because of the large amount of data (Bryman & Bell, 2011), which was also the case with this research. Creswell (2012) describes qualitative data analysis in four steps: (1) organising the data; (2) reading and reflecting of the data; (3) describing, classifying, and interpreting the data; and (4) representing and visualising the data. In both case studies, organising the qualitative data was performed by structuring all available data according to its content, for each case company and relationship respectively. By reading and reflecting on the data, the researchers formulated details for how the data should be analysed. These two steps were an on-going process, performed simultaneously with the data collection. By performing these two steps simultaneously with the data collection, it enabled the researchers to identify gaps in the data collection at an early stage, which could be corrected in the next data collection phase. In both case studies, steps three and four were the most straightforward steps. After step two, which was the most difficult step in both case studies, it was evident how the data should be classified and interpreted. In both case studies, the visualisation of the data analysis was presented in tables.

Eisenhardt (1989) discusses two types of case study analyses: within-case analysis and cross-case analysis, where cross-case analysis requires at least two cases (Yin, 2009). Both case studies included in this thesis include both within-case and a cross-case analyses. The within-case analyses are based on the case descriptions and aims at exploring case-specific relationships, while the cross-case analyses are based on the within-case analyses and searches for common patterns between the case companies. In both case studies, the analyses are performed from a supplier perspective, as information is utilised, and IQ is assessed at the suppliers.

In the Survey study, the data analysis was a lot more straightforward than in the case studies. The data analysis for the Survey study was planned before the data was collected, as the planned analyses impacted the design of the survey questionnaire. Forza (2009) divides the data analysis in survey studies into two phases: preliminary data analysis and hypothesis testing. The preliminary data analysis were used to identify outliers as well as test the coherence of the multi-variable factors (using confirmatory factor analyses), in accordance to Forza (2009). The hypothesis testing was performed with cluster analysis, ANOVA analyses and structural equation modelling (SEM).

The way the analysis was performed differs between the three studies. In the case studies, it has mostly been an inductive process (as described by Kovács & Spens, 2005), where the empirical data steered the analysis. Still, previous research was used to design the interview guides, especially in Case study 2, and in that way effected the analyses. To the contrary, in the Survey study, it has mostly been a deductive process (as described by Kovács & Spens, 2005), where the hypothesized relationships from the literature, as well as from the results of the case studies, was determined before the data was collected. Still, in the cluster analysis, the empirical data had more effect on the data analysis than it had in the SEM models.

In Chapter 6, the results from the data analyses in the three studies are presented. More details about how individual data analyses were performed can be found in the corresponding appended papers. However, Chapter 6 also includes results from some previously unpublished data analyses. These analyses are based on data from the Survey study and consists of hypothesis testing of other combinations of the variables included in the papers. Thus, the preliminary data analyses described in the papers are valid also for these analyses, and the hypothesis testing has been carried out in the same manner as the analyses in the papers.

4.6 Research quality

The quality of quantitative research is often assessed through the quality criteria of internal and external validity, reliability, and objectivity (Guba & Lincoln, 1989). However, even though e.g. LeCompte and Goetz (1982) have tried to adapt the criteria to also fit qualitative research, they are not undoubtedly suitable for qualitative research. Instead, an alternative for qualitative research is to assess research quality through the quality criteria of credibility, transferability, dependability, and conformability (Halldorsson & Aastrup, 2003; Bryman & Bell, 2011), which are more suitable for qualitative research. As the research presented in this thesis is both qualitative and quantitative, both sets of quality criteria are chosen for assessing the quality of the research.

Credibility and internal validity

Credibility refers to the match between the study results and the interviewee's experience of reality (Halldorsson & Aastrup, 2003) and internal validity refers to the extent to which variations in a dependent variable can be attributed to controlled variation in an independent variable (Guba & Lincoln, 1989). Credibility can be achieved through the use of respondent validation and triangulation (Bryman & Bell, 2011) and triangulation is also the main strategy to assure internal validity (Croom, 2009). Triangulation can be performed in different ways, e.g., in terms of methods, data, investigator, and theory (Croom, 2009; Flick, 2009).

In this research, respondent validation was used to assure credibility in the two case studies. Two different types of respondent validation were used: (1) follow-up interviews, where the results from the previous interview was discussed and clarified; and (2) project conferences and project meetings, where preliminary findings were presented, discussed, and validated. In both case studies, the results of the different types of validation confirmed the view of the research, as no mismatches were identified. Method and data triangulation were also used to assure credibility and internal validity, as the research is based on both qualitative and quantitative research methods. In both case studies, interviews were the main data source, however, observations, reviews of internal documents, reviews of shared information, and group discussions were also used in both case studies to complement the interview data. Furthermore, also in the Survey study, group discussions were used to complement the data from the survey questionnaire. In addition to method and data triangulation, investigator triangulation was also used in Case study 2, as two researchers participated in some of the interviews and shared the same view of the studied phenomena.

Transferability and external validity

Transferability refers to the study's ability to make general claims about the world (Halldorsson & Aastrup, 2003) and similar, external validity refers to the general applicability of the conclusions (Croom, 2009). Because of the limited amount of cases in qualitative research, it is difficult to make generalisations of case study results, however, by providing thick descriptions of the case context (Bryman & Bell, 2011), the reader of the findings is able to determine the transferability to its specific situation. Generalisability is easier to assure for

quantitative research, however, external validity requires that the data collection sample is representative of the population it provides conclusions for (Croom, 2009).

Because of the limited number of case companies included in the case studies, it is difficult to generalise the findings of this part of the research. However, as the case studies are designed to be explorative, generalisation is not considered substantial here. Instead, generalisation is more important for findings from the Survey study, as it is designed to be more explanatory. Thus, the main way that this research assures transferability of the case study findings is by the detailed descriptions of the case contexts that are included in the papers, as they allow the readers of the papers to determine the transferability to their specific situations. However, the research assures external validity of the Survey study findings, as all suppliers in the population are included in the data collection sample. Also, non-response bias tests are performed to assure that the respondents of the survey questionnaire do not differ on important factors from the rest of the population.

Dependability and reliability
Dependability refers to the stability of data over time (Guba & Lincoln, 1989) and similarly, reliability refers to how results of a study are repeatable (Bryman & Bell, 2011). Dependability is achieved through detailed records of the different parts of the research process, e.g., problem formulation, case selection, interview notes, and analysis decisions, to enable reviews of how the research has been performed (Bryman & Bell, 2011), while reliability is measured for quantitative data. The most popular measurement for testing reliability is Cronbach's alpha (Forza, 2009) in exploratory factor analyses, and construct reliability in confirmatory factor analyses (Hair et al., 2014).

In the case studies, detailed records have been taken of the different parts of the research process, however, the interview guides and interview notes create a huge amount of data. Thus, even though it is possible to review all documents to get a holistic view of the research process, such a review would be very time consuming, and all documents are thus not included in this thesis. However, in the Survey study, confirmatory factor analyses are performed for all constructs and the measurements, presented in the papers, indicate appropriate reliability.

Confirmability and objectivity
Confirmability refers to the integrity of the findings and it must be possible to track the data to its source and not to the bias of a researcher (Halldorsson & Aastrup, 2003). Similarly, objectivity refers to a demonstration that a given enquiry is free of bias, values and/or prejudice (Guba & Lincoln, 1989). To achieve confirmability, the personal values of the researcher must be set aside, which is a task for other researchers to assess (Bryman & Bell, 2011). Regarding objectivity, several types of potential biases and errors need to be considered for survey research (Blair et al., 2013).

It is impossible for a researcher to perform interviews without any influence on the result of them, however, the researcher has tried to set its personal values aside and influence the research as little as possible. By using an online survey design, at least the potential errors related to the interviewer's influence is limited in the Survey study, however, potential biases and errors still might exist in how the questions and response alternatives are formulated.

4.7 Presentation of results
The results of the three studies are presented in five academic papers, appended to this thesis. Case study 1 ends up in one paper, Paper I; while Case study 2 ends up in two papers, Paper II

and Paper III; and the Survey study ends up in two papers, Paper IV and Paper V. The relationships between the three studies and the five papers are illustrated in Figure 8. In addition, some results from the Survey study are not published in any of the papers but is still included in Chapter 6.

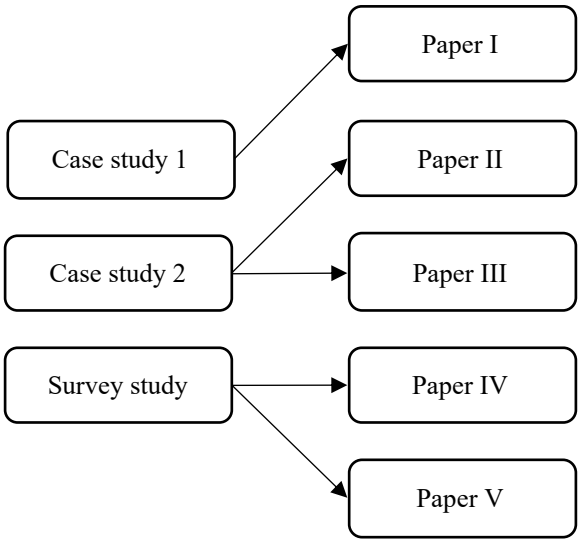

Figure 8 - Relationships between studies and appended papers.

5 Summary of appended papers

This chapter summarises the five papers that are appended to this thesis. Four of the papers are co-authored and a description of the authors' contribution to the appended papers is also provided. At the end of the chapter, a description of how the different papers are used to answer the three research questions is presented.

5.1 Paper I: Information quality deficiencies in delivery schedules and their impact on production scheduling

The purpose of Paper I is to explore how different delivery schedule characteristics affect the quality of shared delivery schedule information and, in turn, how deficiencies in quality affect a supplier's production scheduling process. The paper is based on Case study 1 and its empirical focus is thus a supply network in the Swedish automotive industry, including a supplier that operates as a first-, second-, and third-tier supplier to an OEM. All delivery schedules received by the supplier from the four other actors in the supply network are examined.

The analysis takes a supplier perspective and identifies IQ deficiencies in the delivery schedules from the four actors received by the supplier and relates the deficiencies to additional activities and resources required in the supplier's production scheduling process. The findings show how four delivery schedule characteristics (receiving frequency, planning period, frozen period, and demand variation) create IQ deficiencies in five IQ dimensions (completeness, conciseness, reliability, timeliness, and credibility), and how these deficiencies impact a supplier's production scheduling process by increasing the need for additional activities (rescheduling, rework, and follow-up) and resources (capacity problems, safety time, safety stock, and backlogs) in the process.

5.2 Paper II: Supply chain information utilisation – conceptualisation and antecedents

The purpose of Paper II is to define the concept of supply chain information utilisation and to explore how its determinants (in the paper called antecedents) impact the utilisation of shared demand-related information in an information receiver's planning processes. The paper is based on Case study 2 and its empirical focus is thus an OEM in the Swedish automotive industry and three of its first-tier suppliers. The paper focuses on routinised sharing of formal demand-related information (forecasts, planned orders, firm orders, and inventory levels) utilised in the suppliers' tactical and operational planning processes.

The paper conceptualises supply chain information utilisation by defining four phases of information utilisation and identifies how information sharing, IQ and intended information utilisation determines the actual utilisation of shared demand-related information. Findings show how several inter-organisational (collaborative relationship, information dependency, and social network) and intra-organisational factors (human process involvement, planning system functionality and user-friendliness, and organisational and process structures) in the dyadic relationships are determinants of different phases of information utilisation. The analysis generates 12 propositions regarding the direct and indirect mediating and moderating effects of the determinants on information utilisation and develops a five-phase mediation model to explain how information sharing impacts performance.

5.3 Paper III: Determinants of information quality in supply chains

The purpose of Paper III is to explore how different determinants impact specific IQ dimensions of shared demand-related information in dyadic supply chain relationships. In parallel to Paper II, this paper is also based on Case study 2 and its empirical focus is thus an OEM in the Swedish automotive industry and three of its first-tier suppliers. All types of demand-related information

(forecasts, planned orders, firm orders, inventory levels) shared in the three dyads are examined and the paper focuses on direct determinants of pragmatic IQ deficiencies identified in the dyads.

The analysis takes a determinant-oriented perspective and generates seven propositions relating pragmatic IQ dimensions (relevance, accessibility, credibility, understandability and ease of operation) to their determinants (inter-organisational collaboration, intra-organisational process support, and composite information sharing). The findings identify trade-offs between IQ dimensions and show that different dimensions are beneficially (e.g., trust on credibility), detrimentally (e.g., planning system dysfunction on relevance and ease of operation), varyingly (e.g., information analysis on credibility, depending on analytical results), and conflictingly (e.g., composite information sharing benefits accessibility, credibility, and understandability, yet compromises relevance) impacted by the determinants. Furthermore, the findings show how the determinant impact on ease of use-related IQ dimensions is moderated by information sharing facets.

5.4 Paper IV: Supply chain information utilisation in the automotive industry: A cluster analysis

The purpose of Paper IV is to measure the extent to which suppliers in the automotive industry utilise shared demand-related information and characterise suppliers with different extent of information utilisation. The paper is based on the Survey study and its empirical focus is thus 253 individual suppliers to three OEMs in the Swedish automotive industry. The paper examines the intended utilisation of five individual types of shared demand-related information, which are grouped into three types of information: order information, long-term information (trends and forecasts) and complementary information (inventory levels and forecast accuracy measurements).

A cluster analysis is performed to identify four clusters of suppliers, with different intention to utilise the three types of shared demand-related information. The findings show that the suppliers in one of the clusters intend to utilise the three types of shared information to different extents. The findings also indicate in which sequence suppliers normally develop intended utilisation of the three types of information, if not developed simultaneously. Following the cluster analysis, ANOVA-analyses are performed to compare the characteristics between suppliers in the four clusters. The findings show differences between the clusters in terms of output performance, collaborative relationships, skills and understanding, planning system functionality, and planning process formality and structure, however, no differences are seen regarding the suppliers' business context. Based on the findings, a maturity model for information utilisation is developed.

5.5 Paper V: The performance effect of supply chain information quality and utilisation

The purpose of Paper V is to explain how information utilisation mediates the relationship between IQ and OPC performance for different types of shared demand-related information. In parallel to Paper IV, this paper is also based on the Survey study and its empirical focus is thus 253 individual suppliers to three OEMs in the Swedish automotive industry. The paper examines IQ, intended utilisation, actual utilisation and OPC performance of five individual types of shared demand-related information, which are grouped into three types of information: order information; long-term information (trends and forecasts); and complementary information (inventory levels and forecast accuracy measurements).

Structural equation modelling is used to test the relationships between IQ, intended utilisation, actual utilisation, and OPC performance for the three types of shared demand-related information, respectively. The analyses show that IQ impacts intended utilisation in the same way for all three types of shared information, however, the impact of intended utilisation on actual utilisation, as well as the impact of actual utilisation on OPC performance, differs between the three types of shared information. Additionally, the analysis shows differences in how IQ directly impacts OPC performance for the three types of information.

5.6 Author's contribution to appended papers

Four of the five appended papers are co-authored, while one of the papers is single-authored. The contribution of the author of this thesis to all of the five appended papers are summarised here.

Paper I
Single author. Myrelid has performed all parts of the research process (i.e., research design, literature review, data collection, data analysis, and writing of the paper) herself, with support from her two supervisors.

Paper II
Second author, written together with Patrik Jonsson. The research design and literature review were a joint effort between the two authors. The data collection was mainly performed by Myrelid, and Jonsson participated to an extent. The within-case analysis was a joint effort between the two authors; however, the cross-case analysis was mainly performed by Jonsson. The writing of the paper was a joint effort between the two authors, however, Jonsson had the main responsibility of the writing process.

Paper III
First author, written together with Patrik Jonsson. The research design was a joint effort between the two authors. The literature review was mainly performed by Myrelid. The data collection was mainly performed by Myrelid, and Jonsson participated to an extent. The within-case analysis was mainly performed by Myrelid; however, the cross-case analysis was a joint effort between the two authors. The writing of the paper was also a joint effort, however, Myrelid had the main responsibility of the writing process.

Paper IV
First author, written together with Patrik Jonsson and Carl Wänström. The research design, literature review, data collection, and data analysis were mainly performed by Myrelid, but Jonsson and Wänström participated to an extent. The writing of the paper was a joint effort between the three authors, however, Myrelid had the main responsibility of the writing process.

Paper V
First author, written together with Patrik Jonsson. The research design and literature review were a joint effort between the two authors; however, the data collection and data analysis were mainly performed by Myrelid. The writing of the paper was also a joint effort, however, Myrelid had the main responsibility of the writing process.

5.7 Relationships between papers and answers to research questions

Not all appended papers contribute to the answers to all three RQs in the same extent. Paper I contributes mainly to the answer to RQ3, but somewhat also to the answers to the other two RQs. Paper II contributes mainly to the answer to RQ2, but somewhat also to the answers to

RQ1 and RQ3. Paper III contributes mainly to the answer to RQ2, but somewhat also to the answer to RQ3. Paper IV contributes mainly to the answers to RQ1 and RQ2, but also somewhat to the answer to RQ3, while Paper V mainly contributes to the answer to RQ3. How the five papers contribute to the answers to the three RQs are illustrated in Figure 9.

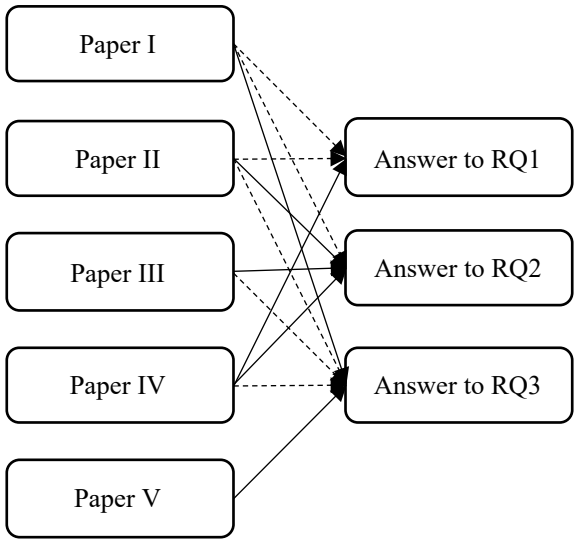

Figure 9 - Relationships between papers and answers to research questions (solid lines show major contribution to the answer and dotted lines show minor contribution to the answer).

6 Results

This chapter presents the results of the research, by answering the three research questions separately.

6.1 Information utilisation in the automotive industry

The first RQ asks how suppliers in the automotive industry utilise shared demand-related information in their OPC processes. The answer to that question is mainly based on results presented in Paper IV, with results presented in Paper I, Paper II, as well as unpublished results from the Survey study contributing to the answer.

To answer the question, it is first necessary to distinguish between two different phases of information utilisation: intended utilisation and actual utilisation. More details of these phases are described in Paper II, but it is however worth noting here that intended utilisation includes an information receiver's willingness and ability to utilise shared information, while actual utilisation occurs when the information is incorporated into the receiver's processes. Intended information utilisation can thus be measured both for information available for the suppliers, but also for potential complements to the shared information, which are not yet available for the suppliers. On the other hand, actual utilisation requires the information to be available, as unavailable information cannot be incorporated into the suppliers' OPC processes.

Regarding intended utilisation, a cluster analysis of the survey data shows that suppliers in the automotive industry can be divided into four clusters, depending on how they intend to utilise three different types of demand-related information (see Table 4). More information of how the clusters were developed can be seen in Paper IV. Low users intend to utilise order information, long-term information and complementary information in a low extent. Medium users intend to utilise the same information in a medium extent and high users in a high extent. However, order users intend to utilise order information in a high extent, while they intend to utilise long-term information and complementary information in a low extent. The Survey study shows that the medium users comprise the largest group of suppliers, as 47% of the studied suppliers are medium users. Approximately 20% of the studied suppliers are order users and about the same amount are high users, leaving the low users as the smallest cluster, with about 12% of the suppliers.

Table 4 - Intended utilisation in the clusters.

	Clusters				**F statistics**
	1. Low users n=29 Mean (SD)	**2. Medium users** n=118 Mean (SD)	**3. Order users** n=50 Mean (SD)	**4. High users** n=52 Mean (SD)	
Order information	4.61 (0.68) [2,3,4]	6.11 (0.44) [1,3,4]	6.40 (0.47) [1,2,4]	6.80 (0.30) [1,2,3]	150.64
Long-term information	4.55 (0.72) [2,4]	5.82 (0.38) [1,3,4]	4.86 (0.82) [2,4]	6.55 (0.45) [1,2,3]	118.70
Complementary information	4.66 (0.70) [2,4]	5.71 (0.39) [1,3,4]	4.44 (0.74) [2,4]	6.57 (0.42) [1,2,3]	165.78

Note: ANOVA tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p<0.05$ level in Bonferroni post-hoc tests.

In Paper IV, a five-cluster solution based on the survey data is also presented. In the five-cluster solution, the order users are divided into two separate sub-clusters, where the suppliers in one of the sub-clusters are intended to utilise long-term information to a significantly higher extent than the suppliers in the other sub-cluster. As no other significant differences are seen between the two sub-clusters, the four-cluster solution (Table 4) are considered most relevant to continue

with for RQ2, however, the five-cluster solution indicates the order for how suppliers in the automotive industry are expected to develop their intended information utilisation, namely that suppliers first are expected to develop the intention to utilise order information, followed by long-term information and, at last, complementary information.

Table 5 shows how many of the suppliers in the Survey study have access to each information type. In the table, it is also seen that there are no biases in the data in terms of accessibility, as no significant differences are seen in the extent of intended utilisation between the suppliers with access to the information and suppliers without. This is not the same for actual utilisation, as only suppliers with access to the information have an extent of utilisation. Out of the 249 suppliers included in the intended utilisation clusters (four suppliers were considered outliers), only 108 suppliers have an extent of actual utilisation for all three types of shared information. It is thus not considered as an alternative to base a cluster analysis on actual utilisation. Instead, the relationship between intended utilisation and actual utilisation is tested with SEM statistics for all three types of information (see Table 6). In Paper V, intended utilisation is divided into willingness and ability to utilise information, however, to compare the results with the cluster analysis, the willingness and ability constructs are here combined into an intended utilisation construct. The three SEM models all show significant regressions as well as acceptable model fit indices. It is shown that the relationship between intended utilisation and actual utilisation is stronger for long-term information and complementary information, compared to order information. Still, the significant regressions indicate that the clusters should be similar to the clusters based on intended utilisation, even if they were based on actual utilisation.

Table 5 - Intended utilisation in relation to information access.

	Order Information Mean (SD) %	**Long-time information** Mean (SD) %	**Complementary information** Mean (SD) %
No access to information	5.75 (0.90) 3%	5.48 (0.90) 22%	5.39 (1.03) 50%
Access to information	6.15 (0.76) 97%	5.66 (0.86) 78%	5.67 (0.76) 50%

Note: Independent sample t-test conducted for identifying biases in the data. Names in brackets [ ] indicate the group from which this group is significantly different at the $p<0.05$ level.

Table 6 – Relationship between intended utilisation and actual utilisation.

	Order information	**Long-term information**	**Complementary information**
Intended utilisation ⇒ Actual utilisation	0.34*	0.62*	0.57*
Chi2	581.96	955.91	489.57
Degrees of freedom	10	10	10
CFI	1.00	1.00	1.00
TLI	0.99	1.01	1.02
RMSEA	0.057	0.000	0.000
SRMR	0.012	0.004	0.003

Note: SEM models conducted to test relationships. * denotes significance at the $p<0.05$ level.

Even though it is not presented in any of the appended papers, the actual utilisation can also be compared between the four clusters (see Table 7). However, it should be noted that actual utilisation is measured by a single variable on a 1-4 scale, while intended utilisation is measured by multiple variables on a 1-7 scale, so Table 7 is not directly comparable with Table 4. Also, for actual utilisation, the number of suppliers included in the clusters vary greatly between the

different types of shared information. However, even though Table 7 does not show significant differences between the clusters in the same extent as for intended utilisation, the means still indicates the same pattern as for intended utilisation.

Table 7 - Actual utilisation in the clusters.

	Clusters				**F statistics**
	1. Low users n=29 Mean (SD)	**2. Medium users** n=118 Mean (SD)	**3. Order users** n=50 Mean (SD)	**4. High users** n=52 Mean (SD)	
Order information	2.80 (0.74) [2,3,4]	3.32 (0.68) [1]	3.24 (0.71) [1]	3.51 (0.65) [1]	6.52
Long-time information	2.93 (1.05) [2,4]	3.69 (0.50) [1,3]	3.29 (0.66) [2,4]	3.80 (0.49) [1,3]	14.24
Complementary information	2.96 (0.95) [4]	3.39 (0.82) [3]	2.33 (1.11) [2,4]	3.69 (0.70) [1,3]	9.24

Note: ANOVA tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p<0.05$ level in Bonferroni post-hoc tests.

The Survey study does not distinguish between different OPC processes, however, Case study 2 shows how the actual utilisation of the three types of shared information varies between different OPC processes (see Table 8). While order information is utilised by all three suppliers in all four OPC processes studied, long-term information is only utilised in the forecasting process and production planning process at one supplier each. Complementary information is utilised by all three suppliers in the order delivery process; however, it is also utilised in the forecasting process and production planning process at one supplier each.

Table 8 – Actual information utilisation in different OPC processes.

	Forecasting	**Production planning**	**MPS and materials planning**	**Order delivery**
Supplier A	Order Long-term Complementary	Order	Order	Order Complementary
Supplier B	-	Order	Order	Order Complementary
Supplier C	-	Order Long-term Complementary	Order	Order Complementary

Note: - signifies the lack of such process.

All three studies investigate supplier information dependency in relation to indented and actual information utilisation. Both Case study 1 and Case study 2 show how the dependency of order information creates a willingness to utilise order information, regardless of how the information is perceived by a supplier. Case study 1 shows how the studied supplier is so dependent on the order information that it both is willing to utilise the information, as well as actually does so, even though the supplier is aware that other information is more reliable. Case study 2 shows how the dependency of order information impacts both the willingness and actual information utilisation for all three suppliers studied, but also how the dependency of long-term information impacts the willingness and actual utilisation for one of the suppliers studied. In the Survey study, several different context variables related to the dependency of information are studied. However, when analysing differences between the clusters, no significant differences are seen for any of the context variables (see Table 9 and Table 10), except for delivery complexity, where the order users are less complex than low users and should thus have less need for shared information. Still, even though it is not significant in the Survey study, the means in the different

clusters indicate that the low users and order users might have less need for shared information, compared to medium and high users.

Table 9 - Cluster need for information (part 1).

	Clusters				Pearson Chi-square
	1. Low users n=29 Category: %	**2. Medium users** n=118 Category: %	**3. Order users** n=50 Category: %	**4. High users** n=52 Category: %	
Supplier manufacturing strategy	MTS: 37.5 MTO: 33.3	MTS: 39.7 MTO: 35.3	MTS: 38.3 MTO: 42.6	MTS: 37.3 MTO: 47.1	3.76
Product uniqueness	Standard: 18.5 Unique: 74.1	Standard: 9.0 Unique: 82.9	Standard: 12.5 Unique: 85.4	Standard: 7.7 Unique: 88.5	5.51
Delivery complexity	Batch: 32.0 Sequence: 40.0 [3]	Batch: 57.5 Sequence: 27.4	Batch: 70.8 Sequence: 16.7 [1]	Batch: 61.2 Sequence: 26.5	11.05
Relationship distance	Nordic: 30.4 Europe: 56.5 Rest: 13.0	Nordic: 20.4 Europe: 68.9 Rest: 10.7	Nordic: 33.3 Europe: 56.3 Rest: 10.4	Nordic: 20.8 Europe: 70.8 Rest: 8.3	4.52

Note: Pearson's Chi-square tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p<0.05$ level.

Table 10 - Cluster need for information (part 2).

	Clusters				F statistics
	1. Low users n=29 Mean (SD)	**2. Medium users** n=118 Mean (SD)	**3. Order users** n=50 Mean (SD)	**4. High users** n=52 Mean (SD)	
Size	2.86 (1.21)	2.82 (1.33)	2.59 (1.15)	3.13 (1.44)	1.47
Supply unreliability	2.24 (0.97)	2.31 (0.89)	2.43 (0.89)	2.49 (0.99)	0.70
Supplier capacity utilisation	2.77 (1.19)	2.83 (1.19)	3.00 (1.29)	2.56 (0.92)	1.18
Supplier dependency	2.65 (1.61)	2.70 (1.41)	2.47 (1.29)	2.67 (1.33)	0.31
Demand variation	2.72 (1.21)	2.98 (1.11)	3.00 (0.99)	2.94 (1.19)	0.42
Product introductions	2.04 (1.30)	1.77 (1.10)	1.54 (0.96)	1.65 (1.06)	1.23
Product models	2.20 (0.87)	2.02 (0.79)	1.96 (0.74)	2.19 (0.82)	1.11
Product lead time	3.78 (1.24)	3.73 (1.35)	4.08 (1.24)	3.88 (1.41)	0.82
Delivery time	3.25 (1.26)	3.52 (1.03)	3.48 (1.05)	3.37 (1.25)	0.50

Note: ANOVA tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p<0.05$ level in Bonferroni post-hoc tests.

6.2 Determinants of information utilisation

The second research question asks how inter- and intra-organisational determinants impact how automotive industry suppliers utilise shared demand-related information in their OPC processes, both (a) directly, and (b) indirectly, through IQ. The answer to that question is mainly based on results presented in Paper II, Paper III, and Paper IV, in addition to the results

presented in Paper I and unpublished results from the Survey study also contributing to the answer.

Case study 2 shows how an inter-organisational collaborative relationship between an OEM and a supplier impacts the actual utilisation of shared demand-related information at the supplier, through the supplier's willingness to utilise the shared information. All three studied suppliers have a collaborative and long-term relationship with the OEM and a mutual attitude that information sharing, and utilisation is important, fostering the willingness to utilise as much information as possible. Furthermore, the case study shows how three intra-organisational factors at a supplier impact the actual utilisation of shared demand-related information at the supplier, through the supplier's ability to utilise the shared information. The three factors are related to both human, technological, and organisational aspects of process support at the supplier and consists of the skills and understanding of individual planners, the functionality of the planning system, and the formality and structure of the OPC processes. In Paper II, several examples are described where individual planners determine the actual utilisation of the shared information through their process involvement, which is based on their own understanding of the shared information. Similarly, several examples are described for how the planning system functionality and the formality and structure of the OPC processes either hinder or enable information utilisation.

Both Case study 1 and Case study 2 show how the quality of shared demand-related information impacts the actual utilisation of the information at a supplier, through both the supplier's ability and willingness to utilise the information. Furthermore, both case studies show that the impact of IQ on information utilisation depends on different IQ dimensions. In Paper II, it is described how the value (relevance and validity) as well as accuracy (reliability and credibility) of shared demand-related information impact a supplier's willingness to utilise the information, and how the format (conciseness, understandability, appropriate amount) as well as availability (accessibility, completeness, timeliness) impact a supplier's ability to utilise the information. In Paper I, it is described how the timeliness and completeness of shared demand-related information impact a supplier's ability to utilise the shared information. Consequently, both case studies show how the indirect impact of inter- and intra-organisational determinants on information utilisation, through IQ, depends on specific IQ dimensions.

Case study 2 also studies the determinantal impact of an inter-organisational collaborative relationship and intra-organisational process support on IQ. Paper III describes how an inter-organisational collaborative relationship impacts the credibility, relevance, accessibility, understandability, and ease of operation, of shared demand-related information, and thus indirectly impact both a supplier's willingness and ability to utilise information. Furthermore, the paper describes how skills and understanding of individual planners at a supplier impact the understandability of shared demand-related information, and thus indirectly impact a supplier's ability to utilise the information. Also, the paper describes how the functionality of the planning system at a supplier impact the relevance and ease of operation of shared demand-related information, and thus indirectly impact both a supplier's willingness and ability to utilise the information. Last, Paper III describes how the formality and structure of the internal information analysis process impacts the credibility of shared demand-related information, and thus indirectly impact a supplier's willingness to utilise the shared information. However, the impact of the internal information analysis process on credibility is not as straightforward as the other determinants, as it is the results of that process, rather than the extent of it, that determines its impact. Based on the two case studies, a summary of the identified determinants

of information utilisation is presented in Table 11, however, the details of the determinantal impact at the studied suppliers are described in the papers.

Table 11 – Determinants of information utilisation.

	Category	**Impact on utilisation**	**Impact on IQ (indirect impact on utilisation)**
Collaborative relationship	Inter-organisational	Willingness to utilise	Credibility (Willingness) Relevance (Willingness) Accessibility (Ability) Understandability (Ability) Ease of operation (Ability)
Skills and understanding	Intra-organisational	Ability to utilise	Understandability (Ability)
Planning system functionality	Intra-organisational	Ability to utilise	Relevance (Willingness) Ease of operation (Ability)
Process formality and structure	Intra-organisational	Ability to utilise	Credibility (Willingness)

The Survey study also examines determinants of information utilisation and IQ, however, it does not analyse specific IQ dimensions individually and does thereby not provide as much detailed understanding of the determinantal impact as the case studies. Still, it validates some of the findings from the case studies on an overall level, as well as provide additional insights of the determinantal impact. When comparing the determinants between the four clusters developed for the first RQ (see Table 12), it is confirmed that all four determinants identified in the case studies impact the supplier's intention to utilise shared demand-related information. However, in the clusters there is no distinction between a supplier's willingness and ability to utilise information. Furthermore, this analysis does not distinguish direct from indirect impact on intended utilisation. However, as described in Paper IV, this analysis indicates that the four determinants are distinctly important for different types of shared demand-related information and for different extent of intended information utilisation. Even though Case study 2 also studies intended information utilisation of different types of information, it does not explicitly study the extent of intended information utilisation.

Table 12 – Determinants in the clusters.

	Clusters				**F statistics**
	1. Low users n=29 Mean (SD)	**2. Medium users** n=118 Mean (SD)	**3. Order users** n=50 Mean (SD)	**4. High users** n=52 Mean (SD)	
Relationship involvement	3.48 (0.70) [4]	3.80 (0.71) [4]	3.83 (0.60) [4]	4.29 (0.59) [1,2,3]	10.23
Skills and understanding	3.72 (0.88) *4*	3.70 (0.71) [4]	3.54 (0.70) [4]	4.18 (0.73) [2,3] *1*	7.25
Information technology	3.42 (0.73) [2,4]	3.85 (0.61) [1,4]	3.82 (0.72) *4*	4.18 (0.77) [1,2] *3*	7.07
Planning processes	3.62 (0.94) [3,4]	3.95 (0.56) [4]	4.13 (0.50) [1]	4.40 (0.69) [1,2]	10.34

Note: ANOVA tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p<0.05$ level in Bonferroni post-hoc tests. Numbers in stars * * indicate the group numbers for which this group is significantly different at the $p<0.10$ level in Bonferroni post-hoc tests.

The cluster analysis shows that an inter-organisational collaborative relationship and intra-organisational skills and understanding are more developed for suppliers in the high user cluster, compared to suppliers in the other clusters, and that no differences are seen between

low users, medium users, and order users. This indicates that a collaborative relationship as well as skills and understanding are especially important for using order information, long-term information and complementary information in a high or very high extent, but not as important for lower extent of intended utilisation. The cluster analysis also shows that the planning system functionality is more advanced for high users than for medium users, as well as more advanced for medium users than for low users. However, no differences are seen between high users and order users or between order users and low users. This indicates that planning system functionality is more important for long-term and complementary information, already from the medium extent of intended utilisation, and not as important for order information, not even for higher extent of intended utilisation. Last, the cluster analysis shows that the process formality and structure are more established for high users compared to medium users, as well as more established for order users than for low users. This indicates that formal and structured processes are especially important for intended utilisation of order information in a high or very high extent, however, it is not as important for long-term information or complementary information, not even for higher extent of intended utilisation.

Contrary to the cluster analysis, the SEM model presented in Paper V distinguishes between willingness and ability, as well as studies their relationships to IQ. However, no determinants are included in that model. By including the determinant constructs (which are tested and confirmed to be valid in Paper IV) in the SEM model, the determinantal impact on willingness, ability and IQ can also be tested on the survey data (see Table 13). Similar to the case studies, the Survey study shows significant determinantal impact of a collaborative relationship on willingness and IQ, but not on ability. In contrary to the case studies, the Survey study does not show significant determinantal impacts of skills and understanding and planning system functionality on ability, however, it does so on IQ. However, the determinantal impact of skills and understanding on IQ is negative, meaning that the more skills and understanding individual planners have, the lower is the perceived IQ. Last, process formality and structure in the Survey study does not have a significant determinantal impact on IQ, but it does so on ability.

Table 13 – Determinantal impact on willingness, ability, and IQ.

	Willingness	**Ability**	**IQ**
Collaborative relationship	0.11*	0.03	0.31*
Skills and understanding	-0.04	0.02	-0.19*
Planning system functionality	-0.09	0.01	0.29*
Process formality and structure	0.04	0.14*	0.06
Chi2	953.02		
Degrees of freedom	268		
CFI	0.96		
TLI	0.95		
RMSEA	0.045		
SRMR	0.032		

Note: SEM model conducted to test relationships. * denotes significance at the $p<0.05$ level.

6.3 The mediating role of information utilisation

The third research question asks how information utilisation mediates the relationship between IQ and OPC performance for different types of demand-related information shared in the automotive industry. The answer to that question is mainly based on results presented in Paper I and Paper V, however, results presented in Paper II, Paper III, Paper IV, and unpublished results from the Survey study also contribute to the answer.

The Survey study tests the proposed research model with SEM statistics for each type of shared demand-related information respectively and the results (Table 14) show that the mediating impact of information utilisation on the relationship between IQ and OPC performance depends on the type of shared information. The relationships between IQ and intended utilisation are significant for order information, long-term information, and complementary information, even though different IQ dimensions are included in the analysis for the different types of shared demand-related information. However, the relationships between intended utilisation and actual utilisation differs between the different types of information, regardless of if the constructs are being measured in the same way for all three types. For order information and long-term information, the impact of intended utilisation on actual utilisation depends only on the supplier's ability to utilise the shared information, whereas for complementary information, the impact depends only on the supplier's willingness to utilise the information. This corresponds to the findings presented in relation to RQ1, how the dependency of order information and long-term information can make a supplier willing to utilise the information, regardless of its perceived IQ.

The results from the model tests also show that long-term information is the only type of shared demand-related information where the extent of actual utilisation impact the output performance of the OPC processes, aside from the quality of the information. For the other types of information, only the quality of the information impacts output performance. Regarding resource performance of the OPC processes, the actual utilisation has a weak impact on preventive resource performance (significant only on $p < 0.1$ level) for complementary information and the quality of long-term information and complementary information is seen to impact corrective resource performance, however, no other impact on resource performance is identified. However, in Paper I, several examples of both output and resource performance effects are seen for order information.

Table 14 – Information utilisation mediation model.

	Order information	**Long-term information**	**Complementary information**
W ⇒ U	-0.04	0.05	0.44***
A ⇒ U	0.37***	0.57***	0.15
A ⇒ W	0.51***	0.75***	0.59***
IQ ⇒ W	0.39***	0.13**	0.29***
IQ ⇒ A	0.58***	0.65***	0.65***
U ⇒ OP	-0.07	0.16**	0.00
U ⇒ PP	0.02	0.01	0.18*
U ⇒ CP	-0.02	-0.05	0.09
IQ ⇒ OP	0.44***	0.29***	0.37***
IQ ⇒ PP	0.02	0.11	0.05
IQ ⇒ CP	-0.06	0.17**	0.20**
Chi2	238.01	359.01	224.86
Degrees of freedom	136	173	137
CFI	0.96	0.96	0.96
TLI	0.95	0.95	0.95
RMSEA	0.056	0.060	0.061
SRMR	0.065	0.053	0.068

Note: SEM models conducted to test relationships. * denotes significance at the p<0.1 level, **denotes significance at the p<0.05 level, *** denotes significance on p<0.01 level.

Complementary to the Survey study, which studies the different types of shared demand-related information separately, Case study 2 also shows that composite information sharing (i.e., the sharing of different types of demand-related information simultaneously) impact the perceived IQ. In Paper III, it also exemplified the impact of composite information sharing on IQ as not as straightforward as most inter- and intra-organisational determinants. Here, composite information sharing is seen to beneficially impact some IQ dimensions, while it detrimentally impacts other dimensions. Furthermore, the paper shows that the impact on credibility depends on the coherence of the different types of demand-related information. The indirect impact of composite information sharing on performance is therefore not obvious.

Even though the Survey data cannot be used to test the impact of composite information sharing on performance, it can be used to test the relationship between composite information utilisation (i.e., the actual utilisation of different types of demand-related information simultaneously) and performance. Here, the actual utilisation of the three information types are combined into a composite information utilisation construct. The results (Table 15) show that the output performance of the OPC processes is significantly improved when all three types of shared demand-related information are utilised simultaneously, however, no impact is seen for resource performance.

Table 15 - Composite information utilisation and its relation to OPC performance.

	Output performance	**Reactive resource performance**	**Corrective resource performance**
Composite information utilisation	0.40*	0.15	0.03
Chi2	1162.25		
Degrees of freedom	91		
CFI	0.98		
TLI	0.97		
RMSEA	0.035		
SRMR	0.070		

Note: SEM model conducted to test relationships. * denotes significance at the p<0.05 level.

The OPC performance is also compared between the four clusters developed for RQ1 (see Table 16). There it is seen that suppliers in the high user cluster have better output performance than the other cluster, while low users have lower output performance, also indicating the performance effect of composite information sharing. However, also here, no difference in resource performance is seen between any of the clusters.

Table 16 - Cluster performance.

	Clusters				**F statistics**
	1. Low users n=29 Mean (SD)	**2. Medium users** n=118 Mean (SD)	**3. Order users** n=50 Mean (SD)	**4. High users** n=52 Mean (SD)	
Output	5.16 (1.00) [2,3,4]	5.84 (0.69) [1,4]	6.01 (0.70) [1,4]	6.41 (0.57) [1,2,3]	19.78
Preventive	4.75 (0.91)	4.91 (1.17)	5.05 (1.03)	5.16 (1.22)	1.01
Corrective	4.41 (1.20)	4.20 (1.40)	3.93 (1.32)	4.39 (1.68)	1.04

Note: ANOVA tests conducted across cluster groups. Numbers in brackets [ ] indicate the group numbers from which this group is significantly different at the $p < 0.05$ level in Bonferroni post-hoc tests.

7 Discussion

This chapter discusses the results of the thesis in relation to previous research as well as in relation to the overall research problem. Chapter 7.1 discusses the three research questions separately, while Chapter 7.2 discusses the overall purpose of the thesis and its contributions.

7.1 Discussion of results

Here, the results of each RQ (presented in Chapter 6) are discussed separately.

7.1.1 Information utilisation in the automotive industry

RQ1 asks how suppliers in the automotive industry utilise shared demand-related information in their OPC processes. The results from the Survey study describe how suppliers in the automotive industry can be divided into four clusters, depending on how they intend to utilise order information, long-term information, and complementary information in their OPC processes. Even though the clusters are developed based on intended information utilisation, the results show similar patterns also for actual information utilisation and confirm a relationship between intended and actual utilisation. It is expected that the low users generate the smallest cluster in the vastly developed automotive industry, however, the finding that only 21% of the studied suppliers are high users indicates that it is not justifiable to continue with the presumption that shared information is utilised by the information receiver, as commonly done in previous research (e.g., by Yu et al., 2001; Bartlett et al., 2007; Paulraj et al., 2008; Wiengarten et al., 2010; Sanders et al., 2012; Şahin & Topal, 2019). Instead, it is necessary to distinguish between the information sharing and information utilisation constructs, to be able to fully understand the value of information sharing.

The survey results describe how one of the identified clusters do not intend to utilise all three types of shared demand-related information in a similar extent. This indicates that it is not enough to study information sharing as an overall construct of all information shared, as commonly done in previous studies (e.g., by Yu et al., 2001; Paulraj et al., 2008; Sanders et al., 2012; Şahin & Topal, 2019). Instead, it is necessary to distinguish between different types of information to fully understand how suppliers intend to utilise shared demand-related information. This finding goes in line with the conclusion presented by Jonsson and Mattsson (2013), that the value of information sharing depends on the information type shared. Jonsson and Mattsson (2013) conclude that planned orders and forecasts have limited value when shared in even or seasonal demand situations, however, major value is seen in promotional situations. Contrarily, they conclude that inventory levels have major value in even and seasonal demand situations, however, no value is seen in promotional situations. Here, the results indicate that the utilisation of order information is developed first, followed by long-term information and then complementary information. The focus on utilising order information and long-term information before using complementary information would be most suitable in the promotional demand situation, out of the situations described by Jonsson and Mattsson (2013), which could be compared with the amplified demand fluctuations seen in the automotive industry (Holweg et al., 2011; Dwaikat et al., 2018).

The results from the Survey study, indicating the sequence for how suppliers in the automotive industry develop information utilisation, correspond to how straightforward the different types of shared demand-related information are to utilise. The results from Case study 2 shows how order information is utilised by all suppliers in all OPC processes studied, which highlights the straightforwardness to utilise this type of information for planning purposes. The utilisation of long-term information is, as expected, concentrated to the more long-term forecasting and production planning processes. Also, long-term information is shown to be straightforward for

the suppliers to utilise, as long as they have structured long-term processes. However, as all suppliers in Case study 2 did not have structured long-term processes, long-term information is considered less straightforward to utilise for planning purposes than order information. Even though complementary information is utilised in many of the different OPC processes, it is utilised differently by different suppliers and are thus considered the least straightforward to utilise.

The results of the Survey study describe that the contextual differences between the clusters are insignificant, indicating that the supplier context is irrelevant for information utilisation. However, both Case study 1 and Case study 2 show how the dependency of shared information, which are related to the case companies' contexts, impacts the extent to which the suppliers utilise the shared information. The results of the case studies go in line with previous research, which argues that information sharing is more important in situations with complex business contexts (Cachon & Fisher, 2000; Lee et al., 2000; Lehtonen et al., 2005; Welker et al., 2008), as the need for information should be higher in those situations. Also, the means from the Survey study indicates that low users and order users might be less dependent on the shared information than the other two clusters even though the differences are not significant.

The answer to RQ1 is summarised in Figure 10, where it is seen how suppliers in the automotive industry are divided into four clusters, depending on the extent they utilise three different types of shared demand-related information. It is also seen that far from all suppliers in the automotive industry fully utilises all types of shared information and that all information types are not utilised in the same extent in all clusters. Furthermore, it is indicated that the information dependency differs between the clusters, where low users and order users are expected to have less need for shared information, compared to medium users and high users. However, as no other contextual differences are seen between the clusters, there is no obvious opportunity for how OEMs could differentiate its information sharing strategies towards different supplier segments.

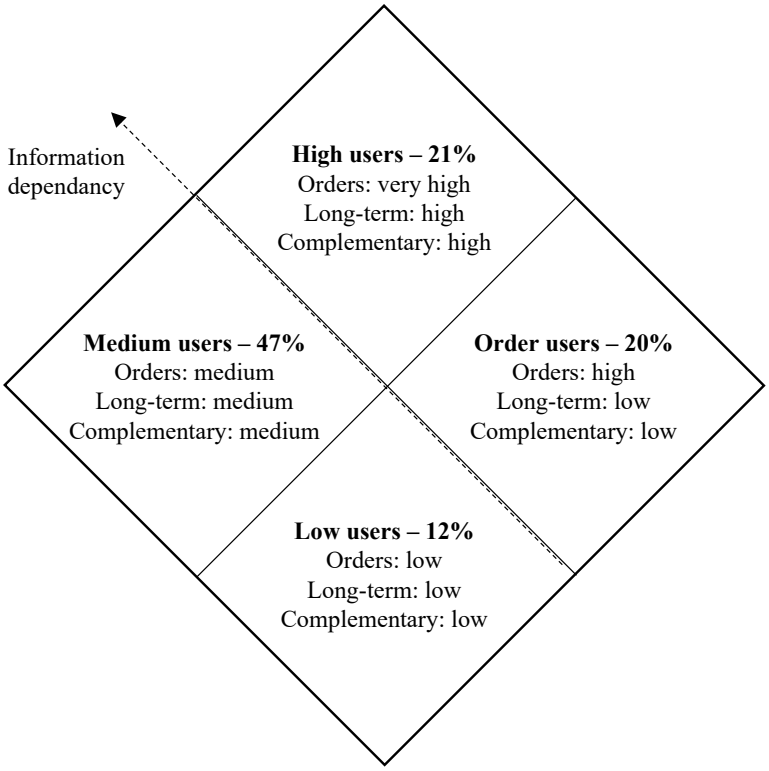

Figure 10 - Clusters of suppliers with different information utilisation.

7.1.2 Determinants of information utilisation

RQ2 asks how inter- and intra-organisational determinants impact how automotive industry suppliers utilise shared demand-related information in their OPC processes, both (a) directly, and (b) indirectly, through IQ. The results from both Case study 2 and the Survey study show how individual IQ dimensions impact a supplier's willingness and ability to utilise shared demand-related information. This is in line with previous research, which points out IQ as important for information utilisation (Moorman et al., 1992; Lee et al., 2010; Bruch & Bellgran, 2013), however, previous research does not explain what aspects of information utilisation are impacted by IQ. Still, the impact on both willingness and ability seems reasonable, based on the definitions of the specific IQ dimensions. For example, relevance refers to how value-adding information is (Wang et al., 1996) and a supplier should be unwilling to utilise shared demand-related information that are invaluable to its OPC processes. Furthermore, accessibility refers to how quickly shared information is available (Wang et al., 1996; Lee et al., 2002) and a supplier should be unable to utilise unavailable information. These results confirm that determinants of IQ also indirectly are determinants of intended information utilisation.

The results from both Case study 2 and the Survey study show how an inter-organisational collaborative relationship between a supplier and an OEM impacts how the supplier utilise shared demand-related information in its OPC processes, both directly and indirectly, through IQ. It is shown that a collaborative relationship impacts actual information utilisation of shared demand-related information through its impact on a supplier's willingness to utilise the shared information. As previous research on determinants of information utilisation is limited, no other study is identified that discusses an inter-organisational collaborative relationship as a determinant of information utilisation. However, it has previously been pointed out as a determinant of IQ (Li & Lin, 2006; Hung et al., 2011; Lu & Yang, 2011), even though its determinantal impact on specific IQ dimensions has not been extensively studied. Still, Jonsson and Gustavsson (2008) study determinants of specific IQ dimensions and they show that trust in a collaborative relationship is important for the credibility, completeness, conciseness, reliability, and timeliness of forecast information. The impact on credibility goes in line with the results of this thesis, however, determinants of inherent IQ dimensions have not been studied here. Instead, the results from Case study 2 show determinantal impact also for the relevance, accessibility, understandability, and ease of operation dimensions, which are not identified by Jonsson and Gustavsson (2008), and thus indirectly impact both a supplier's willingness and ability to utilise shared information. Additionally, the results from the Survey study indicates that a collaborative relationship is most important when utilising different types of shared demand-related in a high extent.

The results from both Case study 2 and the Survey study show how intra-organisational process support at a supplier, in terms of human, technological, and organisational aspects, impacts how the supplier utilise shared demand-related information in its OPC processes, both directly and indirectly, through IQ. It is shown that all three aspects of process support impact actual information utilisation of shared demand-related information through its impact on a supplier's ability to utilise the shared information. However, similar to inter-organisational relationships, none of these aspects are discussed as determinants of information utilisation in previous research. Although all three aspects have previously been pointed out as determinants of IQ (by e.g., Jäckel et al., 2006; Gustavsson & Jonsson, 2008; Jonsson & Gustavsson, 2008; Chen et al., 2014), however, the impact on specific IQ dimensions are rarely studied in previous research. Still, Jonsson and Gustavsson (2008) show that automatic data communication and registration impacts completeness, conciseness, reliability, timeliness, and validity. They

further show that information life-cycle management is important for completeness, timeliness, and validity of forecast information, which are all inherent IQ dimension and thus not studied here. Instead, from Case study 2, it is seen that human process support impacts understandability, technological process support impacts relevance and ease of operation, and organisational process support impacts credibility, which means that intra-organisational process support indirectly impacts both a supplier's willingness and ability to utilise shared demand-related information. Additionally, the results from the Survey study indicate that human process support is most important when utilising different types of shared demand-related information in a high extent, that technological process support is most important for long-term and complementary information, and that organisational process support in the opposite is most important for order information.

The answer to RQ2 is summarised in Figure 11, where it can be seen that both an inter-organisational collaborative relationship as well as intra-organisational process support both have direct, as well as indirect (through IQ), impact on information utilisation. It is also seen that a collaborative relationship and process support differently impact information utilisation directly, through either a supplier's willingness or ability to utilise the shared information. Furthermore, the indirect impact through IQ differs between individual IQ dimensions. However, together, the IQ dimensions impact both a supplier's willingness and ability to utilise shared demand-related information. It should also be noted that the determinantal impact differs between different types of shared information.

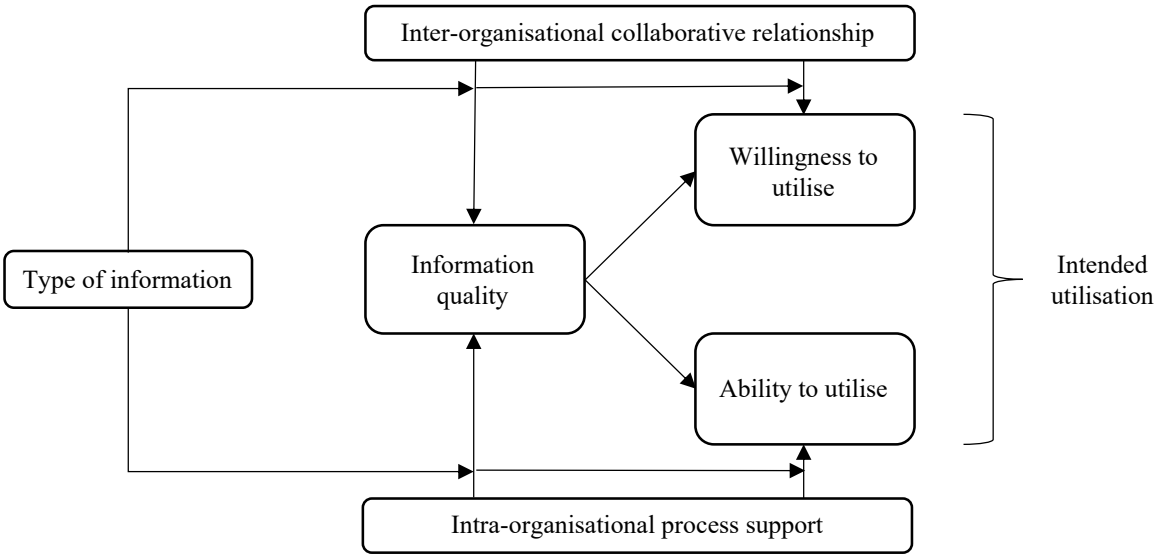

Figure 11 - Direct and indirect determinants of information utilisation.

7.1.3 The mediating role of information utilisation

RQ3 asks how information utilisation mediates the relationship between IQ and OPC performance for different types of demand-related information shared in the automotive industry. The survey results explain how the mediation of information utilisation in the relationship between IQ and OPC performance varies between different types of shared demand-related information. However, the results show that IQ impacts both a supplier's willingness and ability to utilise all studied types of shared demand-related information. These results confirm previous research that point out IQ as a determinant of information utilisation (Moorman et al., 1992; Lee et al., 2010; Bruch & Bellgran, 2013), and explain that IQ is a determinant of intended utilisation, regardless of the type of information.

The survey results explain that the impact of intended utilisation on actual utilisation differs between different types of shared demand-related information. For order information and long-term information, only a supplier's ability to utilise the information impacts actual utilisation, and not the supplier's willingness to do so, while for complementary information it is the opposite. Results from Case study 1 and Case study 2 indicate that the willingness to utilise order information, and to some extent also long-term information, can be based on a supplier's dependency of the information. Thus, if a supplier is dependent on the shared information in their processes, it will only be their ability to utilise the information that determines if the information actually is utilised or not. Suppliers are rarely dependent on complementary information in its processes, and the willingness to utilise the information should thus have a larger impact on if it is utilised or not, compared to order information and long-term information. However, this reasoning does not explain why the ability to utilise complementary information does not impact actual utilisation here.

The survey results explain that the impact of actual utilisation on the output performance of the OPC processes differs between the different types of shared demand-related information. The only type of information where actual utilisation has a significant impact on output performance is long-term information. As most suppliers utilise order information in a high extent, it is not surprising that the extent of order information utilisation does not impact output performance, however, it is not as obvious why complementary information does not have an impact on output performance. Still, the quality of all three types of information have a positive impact on output performance, which confirms previous research on the relationship between IQ and performance (e.g., Barratt & Oke, 2007; Hartono et al., 2010; Wiengarten et al., 2010; Ji-fan Ren et al., 2017). The survey results also explain differences in the mediating effect of actual utilisation on resource performance. Even though complementary information is shown to have both a mediating effect on resource performance as well as an impact from IQ, no such effects are seen for order information or long-term information. However, results from Case study 1 shows how IQ of order information impact both output and resource performance.

The Survey study does not test the relationships between IQ, intended utilisation, actual utilisation and OPC performance for composite information sharing, however, the results from Case study 2 show that composite information sharing impacts perceived IQ, and thus indirectly should impact information utilisation. Also, the results from Case study 2 show that the impact on IQ is not as straightforward as the inter- and intra-organisational determinants, as it can impact different IQ dimensions differently. Furthermore, the Survey study shows how both intended and actual utilisation of composite information have a positive impact on output performance. Thus, even though composite information sharing is not explicitly studied in previous research, it should be important to fully understand the relationship between IQ and OPC performance.

The answer to RQ3 is summarised in Figure 12, where it is seen that some relationships in the mediating model are valid for all types of shared demand-related information studied, while others only are valid for one or two types of information. The relationship between actual utilisation and OPC performance does also exist for composite information utilisation.

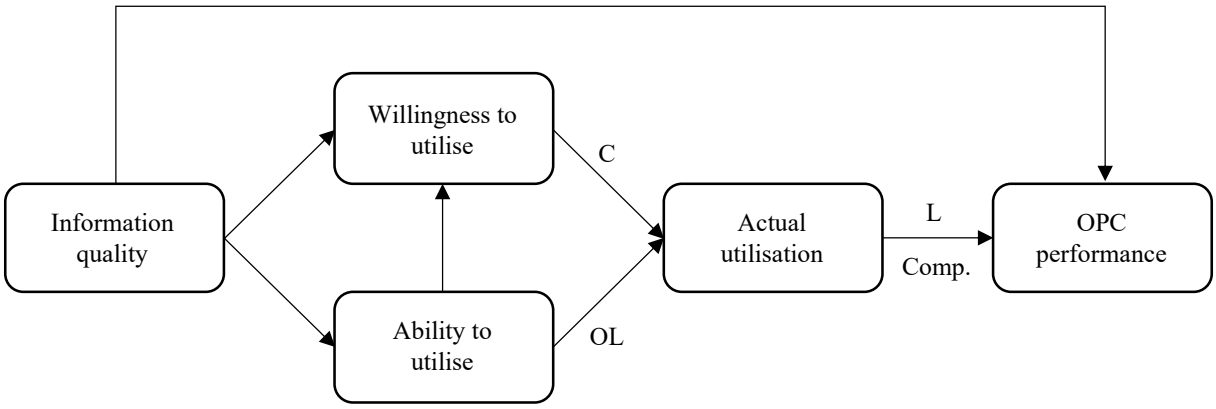

Figure 12 - Mediating role of information utilisation between IQ and OPC performance for different types of shared demand-related information. Letters signifies that the relationship is only shown for the specific type of information (O: order information, L: long-term information, C: complementary information). Comp. signifies that this relationship exists also for composite information utilisation.

7.2 The role of information utilisation for generating value of information sharing

The purpose of the thesis is to provide knowledge about the role of information utilisation in suppliers' operations planning and control processes, for generating value of shared demand-related information in automotive supply chains. By bringing the results from the three research questions together, it is here discussed how the thesis contributes to the understanding of the role of information utilisation for generating value of information sharing, both for academia and for the automotive industry.

7.2.1 Contributions for academia

The model summarising the literature review (Figure 2) is used as a starting point for a conceptual model of information utilisation (Figure 13), based on the findings of this thesis.

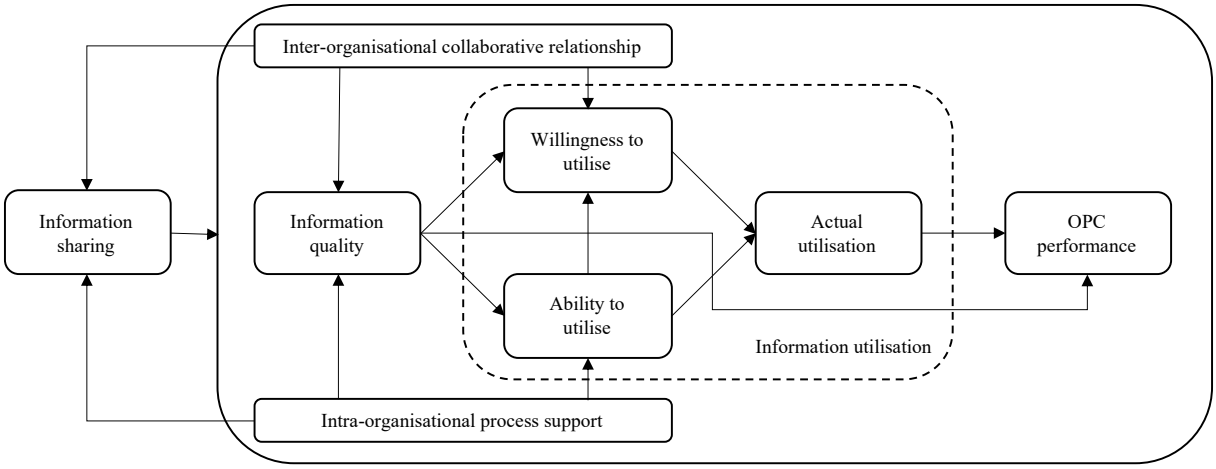

Figure 13 – Conceptual model of information utilisation.

The model is developed into a five-phase model, distinguishing between intended and actual information utilisation, where intended information utilisation is further separated into the willingness and ability to utilise shared information. These divisions are considered important for understanding why shared information is utilised as it is, both because the results show differences between different types of shared information, but also for understanding how the determinants impact information utilisation. Based on the results, it is specified that an inter-organisational collaborative relationship impacts the willingness to utilise shared information and intra-organisational process support impacts the ability to utilise the information, aside from their impact on IQ. It is also important to include the direct relationship between IQ and

OPC performance, which is strengthened by the results showing how the dependency of shared information alone can enforce utilisation of deficient information, motivating the relationship between IQ and OPC performance as long as the information is utilised in some extent. It is also considered important to clarify that information sharing does not only impact IQ, but instead the results show that the type of information shared moderates all the relationships between IQ and OPC performance, even though some of the relationships vary more than others. Thus, all relationships in the conceptual model does not exist for all types of shared information, however, the results show all relationships for composite information sharing, highlighting the critical role of information utilisation for generating value of shared demand-related information.

The value of information sharing is debated in previous research, as many researchers show a positive relationship between information sharing and performance (e.g., Paulraj et al., 2008; Ramayah & Omar, 2010; Laosirihongthong et al., 2011; Sanders et al., 2012; Alzoubi & Yanamandra, 2020), while others do not (e.g., Krause et al., 2007; Field & Meile, 2008; Tan et al., 2010; Liu et al., 2013). The same is true for IQ, where several researchers show a positive relationship to performance (e.g., Barratt & Oke, 2007; Hartono et al., 2010; Wiengarten et al., 2010; Ji-fan Ren et al., 2017), whereas others are unable to do so (e.g., Forslund & Jonsson, 2007). The results in this thesis show how information utilisation is a mediator in these relationships, but also how the mediating effect differs between different types of shared information. These findings explain that information utilisation has a critical role for generating value of information sharing, even though its importance varies between different types of shared information. As the performance effect in previous research is related to the extent and/or quality of shared information, this thesis extends previous research by also relating it to the utilisation of the shared information, which helps to explain conflicting results in previous research. Also, the findings highlight the importance of separating different types of shared information in future information sharing and IQ studies.

Explicit studies of information utilisation are rare in previous research. Instead, it is common in the information sharing and IQ literature to presume that shared information is utilised (e.g., Yu et al., 2001; Bartlett et al., 2007; Paulraj et al., 2008; Wiengarten et al., 2010; Sanders et al., 2012; Şahin & Topal, 2019). To the contrary, in relation to Sener et al. (2019) and Kiil et al. (2019), this thesis presents explicit studies on information utilisation and defines and operationalises the concept. The results show that the previous presumption is not justifiable, as only a minority of the studied suppliers utilise all types of shared information in a high extent. This finding further emphasises the critical role of information utilisation and highlights the importance of including it in future information sharing and IQ studies, which is enabled by the definition and operationalisation of the information utilisation concept.

Aside from the determinants of information sharing (e.g., Li & Lin, 2006; Lee et al., 2010; Chen et al., 2014) and IQ (e.g., Kärkkäinen et al., 2007; Schnetzler & Schönsleben, 2007; Hung et al., 2011; Chen et al., 2014) identified in previous research, the results in this thesis show how an inter-organisational collaborative relationship is a determinant of actual information utilisation through a supplier's willingness to utilise shared information and how intra-organisational process support is as a determinant of actual information utilisation through a supplier's ability to utilise the information. Also, the results show how the determinantal impact differs between different types of shared information. These findings show how the maturity of the determinantal impact how critical the role of information utilisation is for generating the value of information sharing. As IQ is the only direct determinant of information utilisation identified in previous research (Moorman et al., 1992; Lee et al., 2010; Bruch & Bellgran,

2013), this thesis extends previous research by showing how other determinants also directly impact information utilisation. Furthermore, as only a few researchers (e.g., Johansson & Johansson, 2004; Jonsson & Gustavsson, 2008) have previously studied determinants of specific IQ dimensions, this thesis details previous research by showing how the determinants indirectly impact information utilisation through specific IQ dimensions. The findings thus also highlight the importance of separating different IQ dimensions in future IQ studies.

In line with previous research, which argue that information sharing is more important in certain situations (Cachon & Fisher, 2000; Lee et al., 2000; Lehtonen et al., 2005; Welker et al., 2008), the results in this thesis show how the dependency of shared information impacts how the information is utilised. However, the results also show that high utilisation of demand-related information improves performance for many different types of suppliers, not only for those that consider information sharing most important. Thus, this finding details previous research regarding the contextual importance of information sharing and highlights the critical role of information utilisation for many different types of suppliers.

For planning purposes, previous research argues that information sharing can improve both output and resource performance (Sahin & Robinson Jr, 2005; Simatupang & Sridharan, 2005; Wu & Cheng, 2008; Datta & Christopher, 2011) and the results in this thesis confirm this for most types of shared demand-related information. However, the results in this thesis show that the value of utilising shared demand-related information in the OPC processes differs between different types of shared information. Whereas the utilisation of long-term information is shown to have a direct effect on output performance of the OPC processes, the utilisation of complementary information is shown to have a direct effect on resource performance. The utilisation of order information is not shown to have any direct effect on performance, however, its quality is shown to impact output performance and it also exemplifies its impacts on resource performance at a specific supplier.

As all suppliers are required to utilise order information in the OPC processes to some extent, the utilisation of order information is thus still considered important for the value of information sharing. These findings highlight the critical role of information utilisation for planning purposes, for different types of shared demand-related information. The results also show that different types of shared demand-related information are differently utilised in different types of OPC processes, which highlights the importance of also distinguishing between different types of processes when studying information utilisation.

A summary of the theoretical contributions of this thesis is summarised in Table 17.

Table 17 - Summary of theoretical contributions.

To	Subject	How the thesis contributes
Information sharing literature	The supply chain information utilisation concept	- Defines and operationalises the concept, which enables further studies on information utilisation. - Describes why information utilisation cannot be presumed, which highlights the importance of including it in future information sharing studies.
	The mediating role of information utilisation	- Explains the mediating role of information utilisation between information sharing, IQ and performance, which extends previous research and helps explain previously conflicting results. - Shows how the role of information utilisation differs between different types of shared information, which highlights the importance of distinguishing between different types of shared information.
	Determinants of information utilisation	- Shows how determinants, directly and indirectly, impact information utilisation, which extends and details previous research and helps explain previously conflicting results. - Shows how the determinantal impact differs between different types of shared information, which highlights the importance of distinguishing between different types of shared information.
	Information utilisation contexts	- Shows how the dependency of shared information impacts information utilisation, which details previous research. - Shows how information utilisation is beneficial in all types of contexts, which details previous research.
OPC literature	Value of shared information	- Shows the potential to improve the value of shared demand-related information in the OPC processes, which motivates further studies on information utilisation for planning purposes. - Shows how the value of shared demand-related information differs between information types, which highlights the importance of distinguishing between different types of shared information.
	Information utilisation in different OPC processes	- Shows how different types of shared demand-related information are differently utilised in different OPC processes, which highlights the importance of distinguishing between different processes when studying information utilisation.

7.2.2 Contributions for industry

Based on the results in this thesis, indicating in which order suppliers in the automotive industry are expected to develop the utilisation of different types of shared demand-related information and the logic behind this order, a seven-stage maturity model is proposed (Figure 14). As order information is the basis of the information sharing in automotive supply chains, this type of information has a clear value for the suppliers and is also the most straightforward type of information to utilise (Jonsson & Mattsson, 2013). Thereafter, long-term information, which consists of market trends and forecasts, are important when demand is unpredictable (Jonsson & Mattsson, 2013), as common in the automotive industry. However, even though this type of information, which mainly consists of numerical interpretations of future demand, is relatively straightforward to utilise, it is still not as straightforward to utilise as order information, especially since all suppliers do not have structured long-term processes. Last, complementary information, which consists of forecast accuracy measurements and inventory levels, are relatively new types of shared information in the automotive industry, which is why it is uncommon with processes that handle this type of shared information.

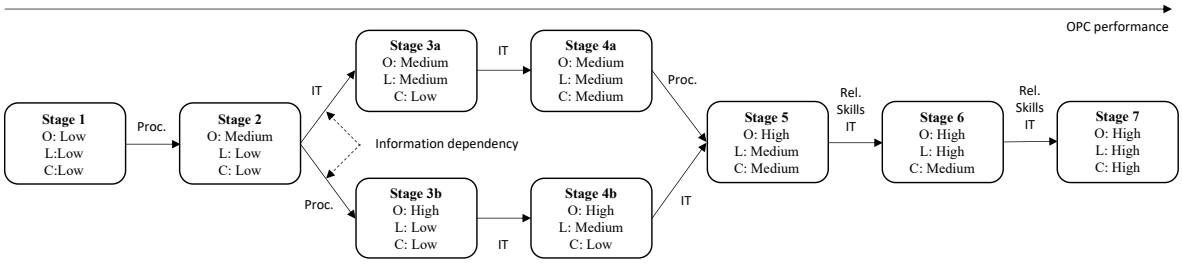

Figure 14 – Information utilisation maturity model.

The results in this thesis show that the OPC performance increases the more the suppliers utilise shared demand-related information in their OPC processes, but it also shows that there is no difference if order information is utilised in a high extent or if the other types of demand-related information are utilised in a medium extent. Even though it is not significantly shown in the Survey study, the results from the case studies show that the dependency of shared information decides which of the two alternatives (stage 3 in Figure 14) is most appropriate. These findings highlight both the importance of distinguishing between different types of shared information, as well as between different dependencies of shared information. Furthermore, based on the results in this thesis, how the importance of the determinants of information utilisation differs between different types of shared information as well as between different extent of utilisation of these types, the maturity model also highlights the most important determinant(s) between each stage.

The results in this thesis show that there is huge improvement potential for suppliers in the automotive industry to increase OPC performance by increasing the utilising of shared information, as a majority of the studied suppliers do not fully utilise all of the demand-related information shared. Also, the developed maturity model has practical implications for both suppliers and OEMs in the automotive industry.

For suppliers, the maturity model points out the importance of striving to become high users of all types of demand-related information shared within the automotive industry, regardless of their context, as high users are characterised with better output performance in their OPC processes. The model also provides guidance on which determinants are most important to focus on in the endeavour to increase information utilisation, and consequently to improve OPC performance. Additionally, the details provided in this thesis can help suppliers to understand how they impact both their own information utilisation as well as their perception of the quality of shared demand-related information. With such knowledge, suppliers can design their OPC processes to increase perceived IQ and information utilisation, and ultimately improve the value of information sharing in the automotive industry.

For OEMs, the maturity model highlights the importance for suppliers in the automotive industry to become high users. A differentiation of the demand-related information sharing strategies towards different supplier segments would thus be inappropriate. Instead, this model shows that it is beneficial for all suppliers' OPC processes if the OEMs share all types of demand-related information with them. However, the model also shows that the OEMs cannot encourage all suppliers to become high users, unless they are willing to develop collaborative relationships with them. Still, parts of the maturity model could be valuable to include in supplier development initiatives, for example in the Odette/MMOG assessment tool (Odette, 2020), which is commonly used by OEMs in the automotive industry for evaluating and improving suppliers. Additionally, the results in this thesis highlight the importance for OEMs

to share high-quality demand-related information with their suppliers, as IQ has a critical impact on the performance of the suppliers' OPC processes. It also shows that it is important to differentiate between IQ dimensions, as composite information sharing conflictingly impact different dimensions, and some dimensions are more important than others for different types of shared demand-related information.

A summary of the practical contributions of this thesis is summarised in Table 18.

Table 18 - Summary of practical contributions for the automotive industry.

To	**Subject**	**How the thesis contributes**
OEMs	What to share	- Shows that it is beneficial to share as much information as possible. - Shows that order information and long-term information is especially important for output performance. - Shows that complementary information is especially important for resource performance.
	With whom to share	- Shows that it is beneficial to share information with all suppliers. - Shows the inappropriateness to differentiate information sharing.
	IQ	- Shows that IQ impacts both a supplier's willingness and ability to utilise information. - Shows that easy-to-use dimensions are especially important for a supplier's ability to utilise shared information, even when it is not dependent on the information.
	How to help suppliers utilise	- Explains how the determinants of information utilisation can be included in supplier development initiatives.
Suppliers	What to utilise	- Shows that it is beneficial to utilise as much information as possible, especially long-term information.
	How to enable utilisation	- Shows how the determinants are differently important for different extent of utilisation and different types of information.

8 Concluding remarks

This chapter concludes the research presented in this thesis by summarizing its results and contributions, as well as limitations and directions for future research.

8.1 Conclusions

This thesis describes suppliers in the automotive industry divided into four clusters, depending on how they utilise order information, long-term information, and complementary information in their OPC processes. Furthermore, the thesis describes that the utilisation of shared demand-related information varies between different types of shared information and different types of OPC processes. It also describes that most suppliers in the automotive industry do not fully utilise all types of shared demand-related information. Moreover, the thesis describes that the dependency of shared information impacts information utilisation, but other than that, supplier context does not seem to have any major impact on how shared demand-related information is utilised in the automotive industry.

The thesis shows how an inter-organisational collaborative relationship as well as human, technological, and organisational process support at a supplier impact how suppliers in the automotive industry utilises shared demand-related information in its OPC processes, both directly and indirectly, through the quality of the shared information. Furthermore, the thesis shows how the impact on actual utilisation is mediated by a supplier's willingness and/or ability to utilise shared information, where a collaborative relationship only impacts the willingness whereas process support only impacts ability. However, the thesis also shows how the indirect impact of both a collaborative relationship and process support, through specific IQ dimensions, impact both a supplier's willingness and ability to utilise shared demand-related information.

The thesis explains that information utilisation mediates the relationship between IQ and OPC performance, but that the mediation differs between different types of demand-related information shared in the automotive industry. The thesis explains that IQ impacts intended utilisation for all types of shared demand-related information, whereas intended utilisation impacts actual utilisation differently for different types of information. For order information and long-term information, it is a supplier's ability to utilise the shared information that determines the actual utilisation, but for complementary information, it is the supplier's willingness that determines it. Furthermore, the thesis explains that actual information utilisation impacts OPC performance, but also this relationship differs between different types of information. Long-term and complementary information utilisation both directly and indirectly impact different parts of OPC performance, whereas order information, which suppliers in the automotive industry is required to utilise to some extent, mainly impact OPC performance through the quality of the shared information.

The thesis contributes to academia by highlighting the critical role of information utilisation for generating value of shared demand-related information in a supplier's OPC processes, as well as stresses the importance of separating different types of shared demand-related information and IQ dimensions in studies of information utilisation. Moreover, the thesis validates IQ as a determinant of information utilisation and extends and details previous research by showing the determinantal impact on information utilisation and specific IQ dimensions. Furthermore, the thesis develops a five-phase conceptual model for how information sharing impacts OPC performance (Figure 13) and explains how this model differs between different types of shared demand-related information. Additionally, the thesis opens up for further research on information utilisation by defining and operationalising the information utilisation concept.

The thesis contributes to practitioners in the automotive industry by showing that the potential value of information sharing is far from reached in the industry and that that the value can be improved by better utilisation of shared demand-related information. Furthermore, the thesis shows that all suppliers should strive to become high users of all demand-related information currently shared in the automotive industry, as it improves the performance of their OPC processes. Moreover, the thesis develops an information utilisation maturity model (Figure 13), which can be used as guidance for both suppliers and OEMs, in their endeavour to improve the value of information sharing in the automotive industry.

8.2 Limitations and future research

This research is limited to two case studies and one survey study. Both case studies include a limited number of case companies, implicating that the context of the specific case companies have a large influence on the findings in these studies. Furthermore, as the Survey study is based on the results from the findings in the case studies, also the findings in the Survey study is somewhat limited, based on the context of the case companies. However, this limitation mostly applies to the second research question in this thesis. Moreover, this limitation does not suppress the findings regarding the determinants identified in the studies, but rather may have prevented also other potential determinants from being identified. For example, for convenience reasons, no long-distance supplier was included in the case studies, and it is possible that other determinants would be more apparent for long-distance suppliers. Still, no differences between long-distance and short-distance suppliers were identified in the Survey study, in terms of the extent that the different suppliers utilised the shared demand-related information. Nevertheless, the context of the suppliers needs further attention and as an alternative for future research it would thus be necessary to include other types of suppliers in future case studies.

All three studies are performed within the automotive industry. As many of the suppliers in the Survey study are global suppliers, and the strategy for sharing large amounts of demand-related information is widespread within the automotive industry, the findings of the Survey study are considered generalisable for other similar settings in the automotive industry. However, since the automotive industry is distinctly different from several other industries, the findings here are consequently not generalisable to all other industries. In other industries, e.g., for fast moving consumer goods, point-of-sales data would be more relevant to study, which is not included here, and suppliers within that industry are likely using shared demand-related information in a different way and thus also are impacted by other determinants. Also, the technology development has enabled the sharing of other types of information, not commonly shared in the automotive industry today. To fully understand the role of information utilisation, similar studies need to be performed also in distinctly different industries and by including other types of shared information.

Case study 2 and the Survey study are limited to only include first-tier suppliers within the automotive industry. Although Case study 1 includes a supply network, the study focuses on the respective dyads in the network, however, the findings still highlight the additional problems with IQ deficiencies experienced by remote suppliers. Since demand-related information is also shared with other actors in a supply chain, and not only adjacent ones, an alternative for future research is thus to extend this research to also include suppliers in other tiers when studying information utilisation, both within case study and survey research.

The conceptual model (Figure 13) opens up several alleys for future research. First, the performance effect in the Survey study is limited to be self-assessed by the studied suppliers, which is a drawback of the thesis. To be able to make any general conclusions regarding the

performance effect of information utilisation, other types of performance data need to be studied as well. Also, the insignificant results in the Survey study regarding preventive and corrective resource performance imply a need for further attention. Second, the diverse importance of willingness and ability for the actual utilisation of the different types of shared information is highlighted, however, it is not clear why willingness and ability are of diverse importance for the different types of information, which would be interesting to study. Third, additional research on specific IQ dimensions could help increase the understanding of how IQ determines information utilisation.

The maturity model (Figure 14) also opens up for future research. The maturity model contains determinants between the different stages, but it is not detailed how companies should work with the determinants to enable information utilisation. More detailed case studies regarding the determinantal impact for different extent of information utilisation would increase the understanding on how to generate value of information sharing. Additionally, an area for the future is to study how to best include the determinants in different supplier development initiatives more specifically.

Overall, this thesis highlights the importance of including information utilisation in future information sharing studies, as well as distinguish between different types of shared information. Moreover, as a complement to the current technology development, which will enable the sharing of both more and additional types of information in the future, this thesis shows that information sharing itself does not generate any value, unless it is known how to utilise it.

References

Affonso, R., Marcotte, F., & Grabot, B. (2008). Sales and operations planning: the supply chain pillar. *Production Planning and Control,* Vol. 19, No. 2, pp. 132-141.

Altug, M. S., & Muharremoglu, A. (2011). Inventory management with advance supply information. *International Journal of Production Economics,* Vol. 129, No. 2, pp. 302-313.

Alzoubi, H., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management,* Vol. 8, No. 2, pp. 273-284.

Armitage, C. J., & Conner, M. (1999). Distinguishing perceptions of control from self-efficacy: Predicting consumption of a low-fat diet using the theory of planned behavior. *Journal of applied social psychology,* Vol. 29, No. 1, pp. 72-90.

Ataseven, C., & Nair, A. (2017). Assessment of supply chain integration and performance relationships: A meta-analytic investigation of the literature. *International Journal of Production Economics,* Vol. 185, No., pp. 252-265.

Auramo, J., Kauremaa, J., & Tanskanen, K. (2005). Benefits of IT in supply chain management: An explorative study of progressive companies. *International Journal of Physical Distribution and Logistics Management,* Vol. 35, No. 2, pp. 82-100.

Babai, M. Z., Ali, M. M., Boylan, J. E., & Syntetos, A. A. (2013). Forecasting and inventory performance in a two-stage supply chain with ARIMA(0,1,1) demand: Theory and empirical analysis. *International Journal of Production Economics,* Vol. 143, No. 2, pp. 463-471.

Baihaqi, I., & Sohal, A. S. (2013). The impact of information sharing in supply chains on organisational performance: An empirical study. *Production Planning and Control,* Vol. 24, No. 8-9, pp. 743-758.

Barnes, S. J., & Vidgen, R. (2012). User acceptance and corporate intranet quality: An evaluation with iQual. *Information and Management,* Vol. 49, No. 3-4, pp. 164-170.

Barratt, M., & Barratt, R. (2011). Exploring internal and external supply chain linkages: Evidence from the field. *Journal of Operations Management,* Vol. 29, No. 5, pp. 514-528.

Barratt, M., & Oke, A. (2007). Antecedents of supply chain visibility in retail supply chains: a resource-based theory perspective. *Journal of Operations Management,* Vol. 25, No. 6, pp. 1217-1233.

Bartlett, P. A., Julien, D. M., & Baines, T. S. (2007). Improving supply chain performance through improved visibility. *The International Journal of Logistics Management,* Vol. 18, No. 2, pp. 294-313.

Bastl, M., Johnson, M., Lightfoot, H., & Evans, S. (2012). Buyer-supplier relationships in a servitized environment: An examination with Cannon and Perreault's framework. *International Journal of Operations and Production Management,* Vol. 32, No. 6, pp. 650-675.

Beamon, B. M. (1999). Measuring supply chain performance. *International Journal of Operations and Production Management,* Vol. 19, No. 3, pp. 275-292.

Bendoly, E., Rosenzweig, E. D., & Stratman, J. K. (2009). The efficient use of enterprise information for strategic advantage: A data envelopment analysis. *Journal of Operations Management,* Vol. 27, No. 4, pp. 310-323.

Bennett, D., & Klug, F. (2012). Logistics supplier integration in the automotive industry. *International Journal of Operations and Production Management,* Vol. 32, No. 11, pp. 1281-1305.

Berglund, M., & Guinery, J. (2008). The influence of production planners and schedulers at manufacturing and commercial interfaces. *Human Factors and Ergonomics in Manufacturing and Service Industries,* Vol. 18, No. 5, pp. 548-564.

Berry, W. L., & Cooper, M. C. (1999). Manufacturing flexibility: methods for measuring the impact of product variety on performance in process industries. *Journal of Operations Management,* Vol. 17, No. 2, pp. 163-178.

Blair, J., Czaja, R. F., & Blair, E. A. (2013). *Designing surveys: A guide to decisions and procedures*: Sage Publications.

Bruch, J., & Bellgran, M. (2013). Characteristics affecting management of design information in the production system design process. *International Journal of Production Research,* Vol. 51, No. 11, pp. 3241-3251.

Bryman, A., & Bell, E. (2011). *Business research methods* (Vol. 3rd edition). New York: Oxford university press.

Bystedt, J. (2015). *Slutrapport för projektet "förbättrad prognosinformation och prognostiseringsprocesser för fordonsindustrins försörjningskedja*. Stockholm: Odette.

Cachon, G. P., & Fisher, M. (2000). Supply chain inventory management and the value of shared information. *Management Science,* Vol. 46, No. 8, pp. 1032-1048.

Cagliano, R., Caniato, F., & Spina, G. (2006). The linkage between supply chain integration and manufacturing improvement programmes. *International Journal of Operations and Production Management,* Vol. 26, No. 3, pp. 282-299.

Cai, S., Jun, M., & Yang, Z. (2006). The impact of interorganizational internet communication on purchasing performance: A study of Chinese manufacturing firms. *Journal of Supply Chain Management,* Vol. 42, No. 3, pp. 16-29.

Cai, S., Jun, M., & Yang, Z. (2010). Implementing supply chain information integration in China: The role of institutional forces and trust. *Journal of Operations Management,* Vol. 28, No. 3, pp. 257-268.

Cannella, S., & Ciancimino, E. (2010). On the bullwhip avoidance phase: Supply chain collaboration and order smoothing. *International Journal of Production Research,* Vol. 48, No. 22, pp. 6739-6776.

Carr, A. S., & Kaynak, H. (2007). Communication methods, information sharing, supplier development and performance: An empirical study of their relationships. *International Journal of Operations and Production Management,* Vol. 27, No. 4, pp. 346-370.

Chan, H. K., & Chan, F. T. S. (2009). Effect of information sharing in supply chains with flexibility. *International Journal of Production Research,* Vol. 47, No. 1, pp. 213-232.

Chatfield, D. C. (2013). Underestimating the bullwhip effect: A simulation study of the decomposability assumption. *International Journal of Production Research,* Vol. 51, No. 1, pp. 230-244.

Chatfield, D. C., Kim, J. G., Harrison, T. P., & Hayya, J. C. (2004). The bullwhip effect - Impact of stochastic lead time, information quality, and information sharing: A simulation study. *Production and Operations Management,* Vol. 13, No. 4, pp. 340-353.

Chen, J. V., Wang, C. L., & Yen, D. C. (2014). A causal model for supply chain partner's commitment. *Production Planning and Control,* Vol. 25, No. 9, pp. 800-813.

Chiang, W. K., & Feng, Y. (2007). The value of information sharing in the presence of supply uncertainty and demand volatility. *International Journal of Production Research,* Vol. 45, No. 6, pp. 1429-1447.

Christopher, M., & Holweg, M. (2011). "Supply Chain 2.0": managing supply chains in the era of turbulence. *International Journal of Physical Distribution and Logistics Management,* Vol. 41, No. 1, pp. 63-82.

Claassen, M. J. T., Van Weele, A. J., & Van Raaij, E. M. (2008). Performance outcomes and success factors of vendor managed inventory (VMI). *Supply Chain Management: An International Journal,* Vol. 13, No. 6, pp. 406-414.

Claudio, D., & Krishnamurthy, A. (2009). Kanban-based pull systems with advance demand information. *International Journal of Production Research,* Vol. 47, No. 12, pp. 3139-3160.

Corsten, D., Gruen, T., & Peyinghaus, M. (2011). The effects of supplier-to-buyer identification on operational performance - An empirical investigation of inter-organizational identification in automotive relationships. *Journal of Operations Management,* Vol. 29, No. 6, pp. 549-560.

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches* (Vol. 3rd edition). Thousand Oaks: Sage publications.

Croom, S. (2009). Introduction to research methodology in operations management. In C. Karlsson (Ed.), *Researching Operations Management* (pp. 43-83). New York: Routledge.

Datta, P. P., & Christopher, M. G. (2011). Information sharing and coordination mechanisms for managing uncertainty in supply chains: A simulation study. *International Journal of Production Research,* Vol. 49, No. 3, pp. 765-803.

Davis, L. B., King, R. E., Hodgson, T. J., & Wei, W. (2011). Information sharing in capacity constrained supply chains under lost sales. *International Journal of Production Research,* Vol. 49, No. 24, pp. 7469-7491.

Dimitriadis, N. I., & Koh, S. C. L. (2005). Information flow and supply chain management in local production networks: The role of people and information systems. *Production Planning and Control,* Vol. 16, No. 6, pp. 545-554.

Dreyer, H. C., Alfnes, E., Strandhagen, J. O., & Thomassen, M. K. (2009). Global supply chain control systems: A conceptual framework for the global control centre. *Production Planning and Control,* Vol. 20, No. 2, pp. 147-157.

Dubois, A., & Araujo, L. (2007). Case research in purchasing and supply management: opportunities and challenges. *Journal of Purchasing and Supply Management,* Vol. 13, No. 3, pp. 170-181.

Dwaikat, N. Y., Money, A. H., Behashti, H. M., & Salehi-Sangari, E. (2018). How does information sharing affect first-tier suppliers' flexibility? Evidence from the automotive industry in Sweden. *Production Planning and Control,* Vol. 29, No. 4, pp. 289-300.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review,* Vol. 14, No. 4, pp. 532-550.

Eksoz, C., Mansouri, S. A., & Bourlakis, M. (2014). Collaborative forecasting in the food supply chain: A conceptual framework. *International Journal of Production Economics,* Vol. 158, No. 1, pp. 120-135.

English, L. P. (1999). *Improving data warehouse and business information quality: methods for reducing costs and increasing profits*. New York: John Wiley and Sons.

Fabbe-Costes, N., & Jahre, M. (2007). Supply chain integration improves performance: the Emperor's new suit? *International Journal of Physical Distribution and Logistics Management,* Vol. 37, No. 10, pp. 835-855.

Fabbe-Costes, N., & Jahre, M. (2008). Supply chain integration and performance: a review of the evidence. *The International Journal of Logistics Management,* Vol. 19, No. 2, pp. 130-154.

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,* Vol. 12, No. 5, pp. 358-368.

Fawcett, S. E., Wallin, C., Allred, C., & Magnan, G. (2009). Supply chain information-sharing: benchmarking a proven path. *Benchmarking: An International Journal,* Vol. 16, No. 2, pp. 222-246.

Field, J. M., & Meile, L. C. (2008). Supplier relations and supply chain performance in financial services processes. *International Journal of Operations and Production Management,* Vol. 28, No. 2, pp. 185-206.

Filippini, R. (1997). Operations management research: some reflections on evolution, models and empirical studies in OM. *International Journal of Operations and Production Management,* Vol. 17, No. 7, pp. 655-670.

Fisher, C., Lauría, E., & Chengalur-Smith, S. (2012). *Introduction to information quality*. Bloomington: AuthorHouse.

Flick, U. (2009). *An introduction to qualitative research* (Vol. 4th edition). London: Sage Publications.

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management,* Vol. 28, No. 1, pp. 58-71.

Forrester, J. W. (1958). Industrial dynamics: a major breakthrough for decision makers. *Harvard business review,* Vol. 36, No. 4, pp. 37-66.

Forslund, H., & Jonsson, P. (2007). The impact of forecast information quality on supply chain performance. *International Journal of Operations and Production Management,* Vol. 27, No. 1, pp. 90-107.

Forza, C. (2009). *Surveys, In: Researching operations management*: Routledge.

Forza, C., & Salvador, F. (2001). Information flows for high-performance manufacturing. *International Journal of Production Economics,* Vol. 70, No. 1, pp. 21-36.

Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. *Journal of Operations Management,* Vol. 19, No. 2, pp. 185-200.

Fry, T. D., Steele, D. C., & Saladin, B. A. (1995). The role of management accounting in the development of a manufacturing strategy. *International Journal of Operations and Production Management,* Vol. 15, No. 12, pp. 21-31.

Gobetto, M. (2014). *Operations management in automotive industries: From industrial strategies to production resources management, through the industrialization process supply chain to pursue value creation*.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly,* Vol. 19, No. 2, pp. 213-236.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park: Sage Publication.

Gustavsson, M., & Jonsson, P. (2008). Perceived quality deficiencies of demand information and their consequences. *International Journal of Logistics Research and Applications,* Vol. 11, No. 4, pp. 295-312.

Gustavsson, M., & Wänström, C. (2009). Assessing information quality in manufacturing planning and control processes. *International Journal of Quality and Reliability Management,* Vol. 26, No. 4, pp. 325-340.

Ha, B. C., Park, Y. K., & Cho, S. (2011). Suppliers' affective trust and trust in competency in buyers: Its effect on collaboration and logistics efficiency. *International Journal of Operations and Production Management,* Vol. 31, No. 1, pp. 56-77.

Hair, J., Black, W., Babin, B., & Anderson, R. (2014). *Multivariate Data Analysis (new int. ed.)*: Harlow: Pearson Education.

Halldorsson, A., & Aastrup, J. (2003). Quality criteria for qualitative inquiries in logistics. *European Journal of Operational Research,* Vol. 144, No. 2, pp. 321-332.

Han, H., Park, A., Chung, N., & Lee, K. J. (2016). A near field communication adoption and its impact on Expo visitors' behavior. *International Journal of Information Management,* Vol. 36, No. 6, pp. 1328-1339.

Harris, F. W. (1913). *How many parts to make at once*.

Harrison, A., & Van Hoek, R. I. (2008). *Logistics management and strategy: competing through the supply chain*: Pearson Education.

Hartono, E., Li, X., Na, K.-S., & Simpson, J. T. (2010). The role of the quality of shared information in interorganizational systems use. *International Journal of Information Management,* Vol. 30, No. 5, pp. 399-407.

Hazen, B. T., Boone, C. A., Ezell, J. D., & Jones-Farmer, L. A. (2014a). Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications. *International Journal of Production Economics,* Vol. 154, No. 1, pp. 72-80.

Hazen, B. T., Huscroft, J., Hall, D. J., Weigel, F. K., & Hanna, J. B. (2014b). Reverse logistics information system success and the effect of motivation. *International Journal of Physical Distribution and Logistics Management,* Vol. 44, No. 3, pp. 201-220.

He, Y., Sun, H., Ni, W., & Ng, S. C. (2017). Re-examining the effects of supplier integration on operations performance: a relational view. *International Journal of Operations and Production Management,* Vol. 37, No. 12, pp. 1702-1721.

Hieber, R. (2002). *Supply chain management: a collaborative performance measurement approach*. Zurich: vdf Hochschulverlag.

Holweg, M., Disney, S., Holmström, J., & Småros, J. (2005). Supply Chain Collaboration: Making Sense of the Strategy Continuum. *European Management Journal,* Vol. 23, No. 2, pp. 170-181.

Holweg, M., Johansson, M. I., & Jonsson, P. (2011, July 3-6, 2011). *The 'reduction-retention conundrum': managing organisational capabilities at times of large-scale economic crises.* Paper presented at the Proceedings of the 18th EurOMA conference, Cambridge, The U.K.

Holweg, M., & Pil, F. K. (2008). Theoretical perspectives on the coordination of supply chains. *Journal of Operations Management,* Vol. 26, No. 3, pp. 389-406.

Hsu, C. C., Kannan, V. R., Tan, K. C., & Leong, G. K. (2008). Information sharing, buyer-supplier relationships, and firm performance: A multi-region analysis. *International Journal of Physical Distribution and Logistics Management,* Vol. 38, No. 4, pp. 296-310.

Huang, G. Q., Lau, J. S. K., & Mak, K. (2003). The impacts of sharing production information on supply chain dynamics: a review of the literature. *International Journal of Production Research,* Vol. 41, No. 7, pp. 1483-1517.

Hung, W. H., Ho, C. F., Jou, J. J., & Tai, Y. M. (2011). Sharing information strategically in a supply chain: Antecedents, content and impact. *International Journal of Logistics Research and Applications,* Vol. 14, No. 2, pp. 111-133.

Huo, B., Haq, M. Z. U., & Gu, M. (2021). The impact of information sharing on supply chain learning and flexibility performance. *International Journal of Production Research,* Vol. 59, No. 5, pp. 1411-1434.

Ivert, L. K. (2012). Shop floor characteristics influencing the use of advanced planning and scheduling systems. *Production Planning and Control,* Vol. 23, No. 6, pp. 452-467.

Ivert, L. K., & Jonsson, P. (2011). Problems in the onward and upward phase of APS system implementation: Why do they occur? *International Journal of Physical Distribution and Logistics Management,* Vol. 41, No. 4, pp. 343-363.

Jacobs, F. R., Berry, W., Whybark, D. C., & Vollmann, T. (2011). *Manufacturing planning and control for supply chain management* (Vol. 6th edition). Boston: McGraw Hill.

Jayaraman, V., Ross, A. D., & Agarwal, A. (2008). Role of information technology and collaboration in reverse logistics supply chains. *International Journal of Logistics Research and Applications,* Vol. 11, No. 6, pp. 409-425.

Ji-fan Ren, S., Fosso Wamba, S., Akter, S., Dubey, R., & Childe, S. J. (2017). Modelling quality dynamics, business value and firm performance in a big data analytics environment. *International Journal of Production Research,* Vol. 55, No. 17, pp. 5011-5026.

Johansson, E., & Johansson, M. I. (2004). The information gap between design engineering and materials supply systems design. *International Journal of Production Research,* Vol. 42, No. 17, pp. 3787-3801.

Jonsson, P. (2008). *Logistics and supply chain management*. Maidenhead: McGraw-Hill.

Jonsson, P., & Gustavsson, M. (2008). The impact of supply chain relationships and automatic data communication and registration on forecast information quality. *International Journal of Physical Distribution and Logistics Management,* Vol. 38, No. 4, pp. 280-295.

Jonsson, P., & Mattsson, S.-A. (2009). *Manufacturing, planning and control*. London: McGraw Hill.

Jonsson, P., & Mattsson, S. A. (2013). The value of sharing planning information in supply chains. *International Journal of Physical Distribution and Logistics Management,* Vol. 43, No. 4, pp. 282-299.

Jäckel, M., Rövekamp, C., & Würfel, A. M. (2006). Beyond digital connectivity: The value of communication and the communication of values. *Production Planning and Control,* Vol. 17, No. 2, pp. 214-223.

Kalaitzi, D., Matopoulos, A., Bourlakis, M., & Tate, W. (2019). Supply chains under resource pressure: Strategies for improving resource efficiency and competitive advantage. *International Journal of Operations and Production Management,* Vol. 39, No. 12, pp. 1323-1354.

Kehoe, D. F., & Boughton, N. J. (2001). New paradigms in planning and control across manufacturing supply chains the utilisation of Internet technologies. *International Journal of Operations and Production Management,* Vol. 21, No. 5-6, pp. 582-593.

Kembro, J., Näslund, D., & Olhager, J. (2017). Information sharing across multiple supply chain tiers: A Delphi study on antecedents. *International Journal of Production Economics,* Vol. 193, No. 2017, pp. 77-86.

Ketzenberg, M. E., Rosenzweig, E. D., Marucheck, A. E., & Metters, R. D. (2007). A framework for the value of information in inventory replenishment. *European Journal of Operational Research,* Vol. 182, No. 3, pp. 1230-1250.

Khouja, M., & Kumar, R. L. (2002). Information technology investments and volume-flexibility in production systems. *International Journal of Production Research,* Vol. 40, No. 1, pp. 205-221.

Kiil, K., Hvolby, H.-H., Trienekens, J., Behdani, B., & Strandhagen, J. O. (2019). From information sharing to information utilization in food supply chains. *International Journal of Information Systems and Supply Chain Management (IJISSCM),* Vol. 12, No. 3, pp. 85-109.

Klein, R. (2007). Customization and real time information access in integrated eBusiness supply chain relationships. *Journal of Operations Management,* Vol. 25, No. 6, pp. 1366-1381.

Klein, R., & Rai, A. (2009). Interfirm strategic information flows in logistics supply chain relationships. *MIS Quarterly,* Vol. 33, No. 4, pp. 735-762.

Kochan, C. G., Nowicki, D. R., Sauser, B., & Randall, W. S. (2018). Impact of cloud-based information sharing on hospital supply chain performance: A system dynamics

framework. *International Journal of Production Economics,* Vol. 195, No., pp. 168-185.
Kovács, G., & Spens, K. M. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution and Logistics Management,* Vol. 35, No. 2, pp. 132-144.
Krause, D. R., Handfield, R. B., & Tyler, B. B. (2007). The relationships between supplier development, commitment, social capital accumulation and performance improvement. *Journal of Operations Management,* Vol. 25, No. 2, pp. 528-545.
Kärkkäinen, M., Laukkanen, S., Sarpola, S., & Kemppainen, K. (2007). Roles of interfirm information systems in supply chain management. *International Journal of Physical Distribution and Logistics Management,* Vol. 37, No. 4, pp. 264-286.
Laosirihongthong, T., Tan, K. C., & Adebanjo, D. (2011). Supply chain management in ASEAN automotive manufacturing industry. *International Journal of Logistics Research and Applications,* Vol. 14, No. 5, pp. 317-333.
Larson, P. D. (2005). A note on mail surveys and response rates in logistics research. *Journal of Business Logistics,* Vol. 26, No. 2, pp. 211-222.
Lau, J. S. K., Huang, G. Q., & Mak, K. L. (2004). Impact of information sharing on inventory replenishment in divergent supply chains. *International Journal of Production Research,* Vol. 42, No. 5, pp. 919-941.
LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research,* Vol. 52, No. 1, pp. 31-60.
Lee, B. C., Kim, P. S., Hong, K. S., & Lee, I. (2010). Evaluating antecedents and consequences of supply chain activities: An integrative perspective. *International Journal of Production Research,* Vol. 48, No. 3, pp. 657-682.
Lee, H. L., So, K. C., & Tang, C. (2000). The value of information sharing in a two-level supply chain. *Management Science,* Vol. 46, No. 5, pp. 626-643.
Lee, H. L., & Whang, S. (2000). Information sharing in a supply chain. *International Journal of Technology Management,* Vol. 20, No. 3, pp. 373-387.
Lee, Y. W., Strong, D. M., Kahn, B. K., & Wang, R. Y. (2002). AIMQ: A methodology for information quality assessment. *Information and Management,* Vol. 40, No. 2, pp. 133-146.
Lehtonen, J. M., Smros, J., & Holmström, J. (2005). The effect of demand visibility in product introductions. *International Journal of Physical Distribution and Logistics Management,* Vol. 35, No. 2, pp. 101-115.
Li, J., Sikora, R., Shaw, M. J., & Woo Tan, G. (2006). A strategic analysis of inter organizational information sharing. *Decision Support Systems,* Vol. 42, No. 1, pp. 251-266.
Li, S., & Lin, B. (2006). Accessing information sharing and information quality in supply chain management. *Decision Support Systems,* Vol. 42, No. 3, pp. 1641-1656.
Li, S., Rao, S. S., Ragu-Nathan, T. S., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management,* Vol. 23, No. 6, pp. 618-641.
Liu, H., Ke, W., Wei, K. K., & Hua, Z. (2013). Effects of supply chain integration and market orientation on firm performance: Evidence from China. *International Journal of Operations and Production Management,* Vol. 33, No. 3, pp. 322-346.
Lu, Y., & Yang, D. (2011). Information exchange in virtual communities under extreme disaster conditions. *Decision Support Systems,* Vol. 50, No. 2, pp. 529-538.
Lumsden, K., & Mirzabeiki, V. (2008). Determining the value of information for different partners in the supply chain. *International Journal of Physical Distribution and Logistics Management,* Vol. 38, No. 9, pp. 659-673.

Lösch, A., & Lambert, J. S. (2007). E-reverse auctions revisited: An analysis of context, buyer-supplier relations and information behavior. *Journal of Supply Chain Management,* Vol. 43, No. 4, pp. 47-63.

Ma, Y., Wang, N., Che, A., Huang, Y., & Xu, J. (2013). The bullwhip effect under different information-sharing settings: A perspective on price-sensitive demand that incorporates price dynamics. *International Journal of Production Research,* Vol. 51, No. 10, pp. 3085-3116.

Manecke, N., & Schoensleben, P. (2004). Cost and benefit of Internet-based support of business processes. *International Journal of Production Economics,* Vol. 87, No. 3, pp. 213-229.

Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*: Sage publications.

Maskey, R., Fei, J., & Nguyen, H.-O. (2020). Critical factors affecting information sharing in supply chains. *Production Planning and Control,* Vol. 31, No. 7, pp. 557-574.

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach: An interactive approach* (Vol. 2nd edition). Thousand Oaks: Sage Publication.

Min, H. (2009). Application of a decision support system to strategic warehousing decisions. *International Journal of Physical Distribution and Logistics Management,* Vol. 39, No. 4, pp. 270-281.

Moberg, C. R., Cutler, B. D., Gross, A., & Speh, T. W. (2002). Identifying antecedents of information exchange within supply chains. *International Journal of Physical Distribution and Logistics Management,* Vol. 32, No. 9, pp. 755-770.

Mohr, J., & Nevin, J. R. (1990). Communication strategies in marketing channels: A theoretical perspective. *The Journal of Marketing,* Vol., No., pp. 36-51.

Moorman, C., Zaltman, G., & Deshpande, R. (1992). Relationships Between Providers and Users of Market Research: The Dynamics of Trust. *Journal of marketing research,* Vol. 29, No. 1, pp. 314-328.

Munir, M., Jajja, M. S. S., Chatha, K. A., & Farooq, S. (2020). Supply Chain Risk Management and Operational Performance: The Enabling Role of Supply Chain Integration. *International Journal of Production Economics,* Vol., No., pp. 107667.

Müller, M., & Gaudig, S. (2011). An empirical investigation of antecedents to information exchange in supply chains. *International Journal of Production Research,* Vol. 49, No. 6, pp. 1531-1555.

Nagati, H., & Rebolledo, C. (2013). Improving operational performance through knowledge exchange with customers. *Production Planning and Control,* Vol. 24, No. 8-9, pp. 658-670.

Narasimhan, R., & Nair, A. (2005). The antecedent role of quality, information sharing and supply chain proximity on strategic alliance formation and performance. *International Journal of Production Economics,* Vol. 96, No. 3, pp. 301-313.

Narayanan, S., Narasimhan, R., & Schoenherr, T. (2015). Assessing the contingent effects of collaboration on agility performance in buyer–supplier relationships. *Journal of Operations Management,* Vol. 33, No., pp. 140-154.

Odette. (2020). MMOG/LE Version 5, Odette International, www.odette.org.

Olhager, J. (2013). Evolution of operations planning and control: from production to supply chains. *International Journal of Production Research,* Vol. 51, No. 23-24, pp. 6836-6843.

Patnayakuni, R., Rai, A., & Seth, N. (2006). Relational antecedents of information flow integration for supply chain coordination. *Journal of Management Information Systems,* Vol. 23, No. 1, pp. 13-49.

Paulraj, A., Lado, A. A., & Chen, I. J. (2008). Inter-organizational communication as a relational competency: Antecedents and performance outcomes in collaborative buyer-supplier relationships. *Journal of Operations Management,* Vol. 26, No. 1, pp. 45-64.

Petersen, K. J., Ragatz, G. L., & Monczka, R. M. (2005). An examination of collaborative planning effectiveness and supply chain performance. *Journal of Supply Chain Management,* Vol. 41, No. 2, pp. 14-25.

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 and Logistics Management,* Vol. 40, No. 6, pp. 435-455.

Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics,* Vol. 135, No. 1, pp. 514-522.

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly,* Vol. 30, No. 2, pp. 225-246.

Ramayah, T., & Omar, R. (2010). Information exchange and supply chain performance. *International Journal of Information Technology and Decision Making,* Vol. 9, No. 01, pp. 35-52.

Reekers, N., & Smithson, S. (1996). The role of EDI in inter-organizational coordination in the European automotive industry. *European Journal of Information Systems,* Vol. 5, No. 2, pp. 120-130.

Robinson, J. K., Fowler, J. W., & Bard, J. F. (1995). Use of upstream and downstream information in scheduling semiconductor batch operations. *International Journal of Production Research,* Vol. 33, No. 7, pp. 1849-1869.

Rollins, M., Pekkarinen, S., & Mehtälä, M. (2011). Inter-firm customer knowledge sharing in logistics services: An empirical study. *International Journal of Physical Distribution and Logistics Management,* Vol. 41, No. 10, pp. 956-971.

Rossin, D. (2007). An exploratory analysis of information quality in supply chains: efficient and responsive models. *Journal of Global Business Issues,* Vol. 1, No. 2, pp. 151-158.

Rota, K., Thierry, C., & Bel, G. (2002). Supply chain management: a supplier perspective. *Production Planning and Control,* Vol. 13, No. 4, pp. 370-380.

Sahin, F., & Robinson, E. P. (2002). Flow coordination and information sharing in supply chains: review, implications, and directions for future research. *Decision Sciences,* Vol. 33, No. 4, pp. 505-536.

Sahin, F., & Robinson Jr, E. P. (2005). Information sharing and coordination in make-to-order supply chains. *Journal of Operations Management,* Vol. 23, No. 6, pp. 579-598.

Şahin, H., & Topal, B. (2019). Examination of effect of information sharing on businesses performance in the supply chain process. *International Journal of Production Research,* Vol. 57, No. 3, pp. 815-828.

Sanders, N. R., Autry, C. W., & Gligor, D. M. (2012). The impact of buyer firm information connectivity enablers on supplier firm performance: A relational view. *International Journal of Logistics Management,* Vol. 22, No. 2, pp. 179-201.

Saunders, M. N. (2011). *Research methods for business students, 5/e*: Pearson Education India.

Schnetzler, M. J., & Schönsleben, P. (2007). The contribution and role of information management in supply chains: A decomposition-based approach. *Production Planning and Control,* Vol. 18, No. 6, pp. 497-513.

Sener, A., Barut, M., Oztekin, A., Avcilar, M. Y., & Yildirim, M. B. (2019). The role of information usage in a retail supply chain: A causal data mining and analytical modeling approach. *Journal of Business Research,* Vol. 99, No., pp. 87-104.

Sheu, C., Yen, H. R., & Chae, B. (2006). Determinants of supplier-retailer collaboration: Evidence from an international study. *International Journal of Operations and Production Management,* Vol. 26, No. 1, pp. 24-49.

Shou, Y., Li, Y., Park, Y., & Kang, M. (2018). Supply chain integration and operational performance: the contingency effects of production systems. *Journal of Purchasing and Supply Management,* Vol. 24, No. 4, pp. 352-360.

Simatupang, T. M., & Sridharan, R. (2005). The collaboration index: A measure for supply chain collaboration. *International Journal of Physical Distribution and Logistics Management,* Vol. 35, No. 1, pp. 44-62.

Skjoett-Larsen, T., Thernøe, C., & Andresen, C. (2003). Supply chain collaboration: Theoretical perspectives and empirical evidence. *International Journal of Physical Distribution and Logistics Management,* Vol. 33, No. 6, pp. 531-549.

Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management* (Vol. 6th edition). Harlow: Pearson Education.

Stadtler, H. (2005). Supply chain management and advanced planning--basics, overview and challenges. *European Journal of Operational Research,* Vol. 163, No. 3, pp. 575-588.

Stank, T. P., Keller, S. B., & Daugherty, P. J. (2001). Supply chain collaboration and logistical service performance. *Journal of Business Logistics,* Vol. 22, No. 1, pp. 29-48.

Stefansson, G. (2002). Business-to-business data sharing: A source for integration of supply chains. *International Journal of Production Economics,* Vol. 75, No. 1-2, pp. 135-146.

Tan, K. C., Kannan, V. R., Hsu, C. C., & Leong, G. K. (2010). Supply chain information and relational alignments: Mediators of EDI on firm performance. *International Journal of Physical Distribution and Logistics Management,* Vol. 40, No. 5, pp. 377-394.

Taylor, D. H. (2000). Demand amplification: has it got us beat? *International Journal of Physical Distribution and Logistics Management,* Vol. 30, No. 6, pp. 515-533.

Terry, D. J., & O'Leary, J. E. (1995). The theory of planned behaviour: The effects of perceived behavioural control and self-efficacy. *British journal of social psychology,* Vol. 34, No. 2, pp. 199-220.

Tokar, T., Aloysius, J. A., Waller, M. A., & Williams, B. D. (2011). Retail promotions and information sharing in the supply chain: A controlled experiment. *International Journal of Logistics Management,* Vol. 22, No. 1, pp. 5-25.

Vanpoucke, E., Boyer, K. K., & Vereecke, A. (2009). Supply chain information flow strategies: An empirical taxonomy. *International Journal of Operations and Production Management,* Vol. 29, No. 12, pp. 1213-1241.

Viet, N. Q., Behdani, B., & Bloemhof, J. (2018). The value of information in supply chain decisions: A review of the literature and research agenda. *Computers & Industrial Engineering,* Vol. 120, No., pp. 68-82.

Vigtil, A. (2007). Information exchange in vendor managed inventory. *International Journal of Physical Distribution and Logistics Management,* Vol. 37, No. 2, pp. 131-147.

Vijayasarathy, L. R. (2010). Supply integration: An investigation of its multi-dimensionality and relational antecedents. *International Journal of Production Economics,* Vol. 124, No. 2, pp. 489-505.

Wang, R. Y., Strong, D. M., & Guarascio, L. M. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems,* Vol. 12, No. 4, pp. 5-33.

Weber, M. M., & Kantamneni, S. P. (2002). POS and EDI in retailing: An examination of underlying benefits and barriers. *Supply Chain Management: An International Journal,* Vol. 7, No. 5, pp. 311-317.

Welker, G. A., van der Vaart, T., & van Donk, D. P. (2008). The influence of business conditions on supply chain information-sharing mechanisms: a study among supply chain links of SMEs. *International Journal of Production Economics,* Vol. 113, No. 2, pp. 706-720.

Whipple, J. M., Voss, M. D., & Closs, D. J. (2009). Supply chain security practices in the food industry: Do firms operating globally and domestically differ? *International Journal of Physical Distribution and Logistics Management,* Vol. 39, No. 7, pp. 574-594.

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

Wikner, J., Towill, D. R., & Naim, M. (1991). Smoothing supply chain dynamics. *International Journal of Production Economics,* Vol. 22, No. 3, pp. 231-248.

Williams, B. D., Roh, J., Tokar, T., & Swink, M. (2013). Leveraging supply chain visibility for responsiveness: The moderating role of internal integration. *Journal of Operations Management,* Vol. 31, No. 7-8, pp. 543-554.

Wilson, R. (1934). *A scientific routine for stock control*: Harvard Univ.

Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information systems research,* Vol. 16, No. 1, pp. 85-102.

Wu, Y. N., & Cheng, T. C. E. (2008). The impact of information sharing in a multiple-echelon supply chain. *International Journal of Production Economics,* Vol. 115, No. 1, pp. 1-11.

Yigitbasioglu, O. M. (2010). Information sharing with key suppliers: A transaction cost theory perspective. *International Journal of Physical Distribution and Logistics Management,* Vol. 40, No. 7, pp. 550-578.

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5th edition). London: Sage Publications.

Youngdahl, W. E., Kellogg, D. L., Nie, W., & Bowen, D. E. (2003). Revisiting customer participation in service encounters: Does culture matter? *Journal of Operations Management,* Vol. 21, No. 1, pp. 109-120.

Yu, W., Jacobs, M. A., Salisbury, W. D., & Enns, H. (2013). The effects of supply chain integration on customer satisfaction and financial performance: An organizational learning perspective. *International Journal of Production Economics,* Vol. 146, No. 1, pp. 346-358.

Yu, Z., Yan, H., & Edwin Cheng, T. (2001). Benefits of information sharing with supply chain partnerships. *Industrial management and Data systems,* Vol. 101, No. 3, pp. 114-121.

Yusuf, Y. Y., Gunasekaran, A., Musa, A., Dauda, M., El-Berishy, N. M., & Cang, S. (2014). A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry. *International Journal of Production Economics,* Vol. 147, No., pp. 531-543.

Zaheer, N., & Trkman, P. (2017). An information sharing theory perspective on willingness to share information in supply chains. *The International Journal of Logistics Management,* Vol. 28, No. 2, pp. 417-443.

Zhou, H., & Benton, W. C. (2007). Supply chain practice and information sharing. *Journal of Operations Management,* Vol. 25, No. 6, pp. 1348-1365.

Zhou, H., Shou, Y., Zhai, X., Li, L., Wood, C., & Wu, X. (2014). Supply chain practice and information quality: A supply chain strategy study. *International Journal of Production Economics,* Vol. 147, No. C, pp. 624-633.

Appendix A – Interview guides

The interviews were performed in Swedish, which explains why the interview guides presented here are in Swedish. All interview questions were not asked in detail during all interviews, and the interview guides presented here is a summary of all interview guides used during the study. Further, the sub-questions related to the presented interview questions are not included here.

Interview guide for Case study 1

1. **Relationen mellan leverantör och kund**

- Hur länge har ni levererat produkter till kunden?
- Hur många olika artiklar levererar ni till kunden?
- Hur levereras produkterna?
- Hur är kunden som kund?
- Hur ser ert avtal ut?
- Är det skillnad på relationen till de olika fabrikerna?
- Hur många av er har direkt kontakt med kunden?
- Vilka kontaktpersoner har ni hos kunden?

2. **Delad planeringsinformation**

- Vilka typer av information får ni från kunden?
- Genom vilka kanaler skickas informationen?
- Hur ser informationen ut?
- Hur ofta tar ni emot informationen?
- Hur lång planeringsperiod innehåller informationen?
- Frångår ni någonsin det ”normala” informationsutbytet?
- Finns det någon information som ni skulle vilja ha som ni inte har tillgång till?

3. **Leveransplaner**

- Får ni mer än en leveransplan från respektive kund?
- Anser ni att det finns några brister i leveransplanerna eller sättet de delas på?
- Hur delas leveransplanerna?
- Hur ofta kommer leveransplanerna?
- På vilken nivå får ni informationen (artikel, artikelgrupp mm)?
- Hur lång planeringshorisont innehåller informationen?
- Vilken planeringsperiod innehåller informationen?
- Vilken frystid har informationen?
- Hur mycket litar ni på informationen?
- Hur pålitlig är informationen (mäts den)?

4. **Planeringsprocesser**

- På vilka olika nivåer har ni planeringsprocesser?
- Hur ser planeringsprocesserna ut?
- Vilka personer är involverade i de olika planeringsprocesserna?
- Hur ser kommunikationen ut mellan de olika planeringsnivåerna?
- Planerar man för mer än den specifika fabriken?
- Finns det några beslutspunkter i de olika processerna?

5. **Informationsanvändning**

- Vilka personer tar emot information från kunden?
- Vad händer med informationen när den tagits emot?
- Hur tolkas informationen?
- Använder ni all information?
- Vad använder ni informationen till?
- Hur används informationen?
- Görs det några ändringar i informationen innan den används?
- Vilken information används/används inte?
- Varför/varför inte används informationen?

6. **Variationer i informationen**

- Hur upplevs efterfrågan variera?
- Hur lätt är det att förutspå efterfrågan?
- Hur ofta sker det stora ändringar i efterfrågan?
- Vet ni vad det är som gör att stora variationer i efterfrågan uppstår?
- Vad får variationen i efterfrågan för konsekvenser för er?
- Hur gör ni för att hantera variationerna i efterfrågan?
- Sker informationsdelningsprocessen annorlunda ut när det sker stora variationer i efterfrågan jämfört med normala situationer?

Interview guide for Case study 2

Different interview guides were used for the OEM and the suppliers.

Interview guide for the OEM

1. **Relationen till leverantörerna**

- Hur länge har ni haft dem som leverantörer?
- Vad är skillnaderna mellan de olika leverantörerna?
- Har det skett någon förändring i relationerna?
- Köper ni många olika typer av artiklar från leverantörerna?
- Vilka är kontaktpersoner hos leverantörerna och hos er?
- Har ni någon intern kommunikation kring leverantörerna?
- Vad ställer ni för krav på leverantörerna?
- Ställer de några krav på er?

2. **Informationsdelning**

- Vad för typer av information skickar ni till leverantörerna?
- Får leverantörerna olika typer av information från er?
- Vilka avdelningar/personer skickar information till leverantörerna?
- Har leverantörerna någon möjlighet att kommentera informationen?

3. **Webcast**

- Varför började ni använda webcasten?
- Hur tas materialet till webcasten fram?
- Hur förhåller sig webcasten till produktionsprogrammen?
- Vad är det meningen att webcasten ska bidra med?

4. Produktionsprogram

- Vad innehåller produktionsprogrammen?
- Hur förmedlas produktionsprogrammen?
- Hur tas produktionsprogrammen fram?
- Vad är det för skillnad på de fasta och preliminära programmen?
- Hur förhåller sig programinformationen till leveransplanerna?
- Vilken information kring produktionsprogrammen ger ni leverantörerna?
- Har alla era leverantörer tillgång till produktionsprogrammen?
- Skiljer sig produktionsprogrammen något för olika leverantörer?
- Varför började ni dela med er av produktionsprogrammen?
- Vet ni hur leverantörerna använder produktionsprogrammen?
- Hur anser ni att leverantörerna bör använda produktionsprogrammen?
- Följer ni upp produktionsprograms-användningen hos leverantörerna?
- Hur mäts kvaliteten i produktionsprogrammen?
- Finns det någonting som ni ser som skulle kunna göras annorlunda?
- Får ni någon feedback från leverantörerna?

5. Programmöten

- Vilka leverantörer har ni programmöten med?
- Vilka är delaktiga på programmötena?
- Vad tas upp på programmötena?
- När har ni dessa möten?
- Vad blir skillnaden för de leverantörer som har programmöten jämfört med de som inte har?
- Vad händer om en leverantör inte kan klara av produktionsprogrammet?

6. Leveransplaner

- Vad innehåller leveransplanerna?
- Hur förmedlas leveransplanerna till leverantörerna?
- Hur tas leveransplanerna fram?
- Hur förhåller sig leveransplanerna till produktionsprogrammen?
- Vilken information kring leveransplanerna ger ni leverantörerna?
- Har alla era leverantörer tillgång till leveransplanerna?
- Skiljer sig leveransplanerna något för olika leverantörer?
- Varför delar ni med er av leveransplaner till era leverantörer?
- Vet ni hur leverantörerna använder leveransplanerna?
- Hur anser ni att leverantörerna bör använda leveransplanerna?
- Följer ni upp leveransplans-användningen hos leverantörerna?
- Hur mäts kvaliteten i leveransplanerna?
- Finns det någonting som ni ser som skulle kunna göras annorlunda?
- Får ni någon feedback från leverantörerna kring leveransplanerna?

7. Onlinesystemet

- Vad innehåller onlinesystemet?
- Vilken information kring onlinesystemet ger ni leverantörerna?
- Hur förhåller sig onlinesystemet till leveransplanerna?
- Vilka leverantörer har tillgång till onlinesystemet?
- Varför började ni använda er av onlinesystemet?

- Vet ni hur leverantörerna använder onlinesystemet?
- Hur anser ni att leverantörerna bör använda onlinesystemet?
- Följer ni upp onlinesystem-användningen hos leverantören?
- Finns det någonting som ni ser som skulle kunna göras annorlunda?
- Får ni någon feedback från leverantörerna kring onlinesystemet?

Interview guide for the suppliers

1. **Företagsinformation**

- Historik och nuvarande situation?
- Översiktlig organisationsbeskrivning?

2. **Relation till kunden**

- Hur länge har kunden varit kund?
- Vad karakteriserar relationen med kunden?
- Hur många och vilka kontaktytor finns mot kunden?
- Vilka produkter levereras till kunden?
- Hur levereras produkterna?
- Vilka krav ställer kunden på leveransservice?

3. **Planering**

- Vad har man för olika planeringsprocesser?
- Vem utför de olika processerna?
- KPIer och mål för de olika processerna?
- Vad används de olika processerna till?
- Vad använder man för IT support i de olika processerna?
- Hur 'bra' fungerar processerna?

4. **Prognosprocessen**

- Hur varierar produkternas efterfrågan?
- Hur ser prognosprocessen ut?
- Mäter ni prognosfelet?
- Vilken data används i prognosprocessen?

5. **Produktionsplanering**

- Hur planeras produktionen?
- Hur ser försörjningskedjan ut?
- Vilka är de kritiska produktions-/försörjningsresurserna?
- Om man producerar mot lager, hur planeras lagren?
- Hur tar man hem material till produktionen?
- Vilken data används i produktionsplaneringen?

6. **Operativ styrning**

- Vad är syftet med den operativa styrningen?
- Vilka aktörer är involverade?
- Hur ser kontaktytan ut mot kunden?
- Vilken data används för styrningen?

7. Informationsdelning

- Vilken efterfrågerelaterad information erhålls från kunden?
- Hur överförs informationen?
- Vilket format har respektive överförd information?
- Mellan vilka överförs respektive information?
- När och hur frekvent överförs respektive information?
- Upplever ni några problem med datan?

8. Informationsanvändning

- Vilken delad information används i vilken process?
- Vilken delad information används inte?
- Varifrån kommer informationen som man använder?
- Vilket är 'värdet' av att ha tillgång till respektive informationstyp?
- Vilken ytterligare information hade varit bra att ha tillgång till?

9. Hinder/möjliggörare för informationsanvändning

- Vilka hinder/möjligrörare ser ni för informationsanvändningen?
- Vad fungerar bra?
- Vad fungerar mindre bra?

10. Webcast

- Hur får ni tillgång till webcasten?
- Vad gör ni med informationen i webcasten före användning?
- Hur används informationen i webcasten i er organisation/processer?
- Vilka hos er har tillgång till webcasten?
- Upplever ni några problem med webcasten?
- Vad hindrar/möjliggör användningen av datan?

11. Produktionsprogram

- Hur får ni tillgång till det preliminära/fasta produktionsprogrammet?
- Vad skiljer de preliminära produktionsprogrammen från de fasta?
- Vad gör ni med informationen före användning?
- Hur används informationen i produktionsprogrammet?
- Vilka hos er har tillgång till programinformationen?
- Upplever ni några problem med programdatan?
- Vad hindrar/möjliggör användningen av datan?

12. Leveransplaner

- Hur får ni tillgång till leveransplanerna?
- Vilken data innehåller planerna?
- Vad gör ni med datan före användning?
- Hur används datan i er organisation/processer?
- Hur registreras datan i egna system?
- Vilka hos er har tillgång till leveransplanerna?
- Upplever ni några problem med datan?
- Vad hindrar/möjliggör användningen av datan?

13. Onlinesystemet

- Hur ser gränssnittet i onlinesystemet ut?
- Hur ofta uppdateras onlinesystemet?
- Vilka hos er har tillgång till onlinesystemet?
- Vilken data i onlinesystemet används?
- Vad hindrar/möjliggör användning av datan?

14. Telefon/email

- Vem kan ringa/maila?
- Vilka ärenden kan samtalen/mailen handla om?
- Vilken information kan förmedlas via telefon/email?
- Hur används denna information?
- Vad hindrar/möjliggör användning av datan?

15. Informationskvalitet

- Upplever ni några problem med informationen ni får?
- Kan ni uppskatta informationens kvalitet för varje informationstyp?

Appendix B – Survey design

Survey design within Case study 2

The survey performed within Case study 2 was performed in Swedish, which explains why the survey questions presented here are also in Swedish. The survey design below shows the survey questions used for delivery schedule information. Similar survey questions were used for the other types of information objects as well.

1. Informationen innehåller all nödvändig data

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

2. Alla nödvändiga förklaringar av data finns tillgängliga

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

3. Informationen kan användas direkt, utan omarbetning

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

4. Informationen innehåller få fel, dvs informationen speglar verkligheten väl, på kort sikt (ca 2 veckor)

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

5. Informationen innehåller få fel, dvs informationen speglar verkligheten väl, på medellång sikt (ca 3 månader)

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

6. Informationen innehåller få fel, dvs informationen speglar verkligheten väl, på lång sikt (längre än 6 månader)

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

7. Informationen mottas alltid före den behövs

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

8. Informationen mottas med korrekta intervall, dvs inte för ofta eller för sällan

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

9. Kunden använder samma mått (t.ex. tidsenhet, planeringsobjekt, aggregeringsnivå) som vi använder internt

   Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

10.Informationen om leveransplanen är enkelt tillgänglig hos kunden när vi behöver den

Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

11.Informationen är enkelt tillgänglig internt om den behöver återskapas
Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

12.Informationen är trovärdig

Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

13.Informationen är alltid relevant för vårt arbete

Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

14.Informationen är enkel att förstå

Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

15.Informationen är enkel att omarbeta så att den passar våra ändamål
Stämmer inte alls 1 2 3 4 5 6 7 Stämmer väl

Survey design within the Survey Study

Factor	**Based on**	**Variable**	**Formulation**
Information quality	Gustavsson and Jonsson (2008), Lee et al. (2002)	IQ1	This information always includes all necessary values (e.g. quantities, dates etc.)
		IQ2	This information always includes all necessary explanations of the values (e.g. headings etc.)
		IQ3	This information can be used directly, without reworking (e.g. erasing, filtering etc.)
		IQ4	This information is always received in time for our planning tasks
		IQ5	This information contains the same measurement units as we use internally (e.g. time units, aggregation levels etc.)
		IQ6	This information is always easily accessible when needed
		IQ7	This information contains neither too much nor too little data for our needs
		IQ8	This information is always believable
		IQ9	This information is relevant for our planning tasks
		IQ10	This information is easy to understand
		IQ11	This information is easy to rework to fit our needs
Willingness to utilise	Armitage and Conner (1999), Barnes and Vidgen (2012), Han et al. (2016), Terry and O'Leary (1995), Wixom and Todd (2005)	W1	We find this information useful for our processes
		W2	Using this information improves our ability to make good decisions
		W3	We would like to use this information in our processes on a regular basis
Ability to utilise	Armitage and Conner (1999), Barnes and Vidgen (2012), Han et al. (2016), Terry and O'Leary (1995), Wixom and Todd (2005)	A1	If we wanted to, it would be easy for us to use this information in our processes
		A2	We have the knowledge needed to use this information in our processes
		A3	We have the resources (for example a suitable information system) needed to use this information in our processes
Actual utilisation	-	U	Please indicate the extent to which your organisation uses … from the specified OEM.

Output performance	Forslund and Jonsson (2007)	OP1	For the specified OEM we perform perfect…	Promised lead time (the time between placing and receiving an order)
		OP2		On-time delivery (orders are delivered at agreed time)
		OP3		Rush orders when needed
		OP4		Promised inventory availability (to what degree orders can be delivered from inventory)
		OP5		Accurate orders (the right number of items ordered delivered)
		OP6		Availability of delay information
Preventive resource performance	Forslund and Jonsson (2007)	PP1	To perform the promised customer service to the specified OEM we use…	Safety stock in raw material inventory
		PP2		Safety stock in finished goods inventory
		PP3		Safety capacity
		PP4		Safety lead time
		PP5		Over-planning (demand hedges)
Corrective resource performance	Forslund and Jonsson (2007)	CP1	To perform the promised customer service to the specified OEM we use…	Subcontracting
		CP2		Expediting
		CP3		Part delivery
		CP4		Re-scheduling
		CP5		Reservation breaking
		CP6		Overtime
		CP7		Express transports
Collaborative relationship	Li and Lin (2006), Lu and Yang (2011)	Col1	To what extent do you agree with the following statements regarding your plant's relationship to the specified OEM?	The specified OEM has been open and honest in dealing with us
		Col2		We and the specified OEM have invested a lot of effort in our relationship
		Col3		We and the specified OEM have a similar understanding about the aims and objectives of the supply chain
		Col4		We have frequent communication with some employees at the specified OEM
Skills and understanding		Skill1	To what extent does the planning personnel in your plant…	Receive formal education or training related to their jobs (e.g. internal or external competence development courses)
		Skill2		Have a university degree or other higher education
		Skill3		Work in teams for learning purposes (e.g. for problem solving, process development etc.)
Planning system		PS1	To what extent is your plant's planning system(s)…	Having functionalities suitable for our planning processes
		PS2		Easy to use
Planning processes		Proc1	To what extent does your plant have well-established formal process structures and standardized working methods regarding…	Sales and operations planning
		Proc2		Forecasting
		Proc3		Capacity planning
		Proc4		Production planning
		Proc5		Materials planning
		Proc6		Outbound order deliveries
Size		Size	How many employees does your plant have at the moment?	
Supply complexity	Wagner and Bode, 2008	Supply	To what extent has your plant in the past three years experienced problems in your supply chain due to poor performance of your suppliers?	

Supplier complexity	Fry et al. (1995), Gustavsson and Jonsson (2008)	Sup1	What is your plant's main production orientation, regarding the products delivered to the specified OEM
		Sup2	How difficult would it be for your plant to increase your production volumes of your main product family delivered to the specified OEM, within three months?
		Sup3	What percentage of your plant's total turnover is represented by the specified OEM?
Demand complexity		Demand	To what extent does your plant experience that the ordered volumes from the specified OEM varies between different delivery days?
Product complexity	Gustavsson and Jonsson (2008)	Prod1	The products delivered from your plant to the specified OEM are…
		Prod2	How many phase-ins / phase-outs of new / old part numbers in TOTAL has your plant managed for the specified OEM during the last year?
		Prod3	How many different part numbers in TOTAL have your plant delivered to the specified OEM during the last year?
		Prod4	What is your plant's AVERAGE cumulative lead time for the products in your main product family, delivered to the specified OEM (from ordering materials / components until the product is ready for delivery)?
Delivery complexity		Del1	What is your plant's main delivery strategy towards the specified OEM?
		Del2	What is the NORMAL delivery lead time from your plant / storage facility to the specified OEM?
Relationship complexity		Rel	In what country* is your plant located?

** Country is translated into an ordinal scale depending on distance from the buyer.*