June 2019

CAN SOMEONE BURST THE BUBBLE?

An exploration of Industry 4.0 in collaborative settings within the logistic domain, as a first step towards implementation.

Author:

Dennis Schreinders

S1619608

Organization:

University of Twente

Faculty of BMS

Master BA

Committee:

Dr. A.M. Von Raesfeld - Meijer

Ir. B. Kijl

G. Alders (Emons)

M. Wouterse (Emons)

UNIVERSITY OF TWENTE.

EMONS GROUP

June 2019

ACKNOWLEDGEMENTS

This is the master thesis of Dennis Schreinders, written for the master study Business Administration at the University of Twente. The thesis contains a research that has been carried out at Emons Group. The topic of this research/thesis focusses on the trend of Industry 4.0 in collaborative settings. Emons is a SME that is active in the logistic industry. As one of many, Emons perceive a potential for themselves through industry 4.0, while acknowledging their current unpreparedness for implementing these new technologies. To help companies like Emons with this current unpreparedness within this topic, this research suggests exploring the field of industry 4.0 in collaborative settings as a first step towards implementation. This exploration is carried out at their customers to gain insights on their experience, drivers, barriers and partner preferences within this specific domain.

In the last five months at Emons I became a little familiar in the wide world of logistics. I remember my introduction with Marcel Wouterse at the Logistics and IT fair in Utrecht, where I witnessed a master class in the for me completely new and complex world of control towers within logistics. In the following weeks I tried to become known in this area and noticed soon that my knowledge in logistics in general was not sufficient. Digging deeper into a subject that is relatively new to me during a master thesis, is a true challenge. The urge of overcoming this challenge feels like an adventure to me and that triggers. Over this rollercoaster period of getting to know the subject, determining a solid research direction, adjusting to a new company culture and managing expectations from the university, I feel like I am more than ready for the next chapter in my life.

First of all, I would like to thank Sebastiaan Piest for connecting me with the company Emons at the point I was a little lost in looking for a master thesis subject. Second, I would like to thank the company Emons that provided all the room and hospitality for working on my thesis. A special thanks to my external supervisors Gerard Alders and Marcel Wouterse for their valuable support during my thesis period. I would also like to thank William Emons that assisted me during the interview days and helped me connecting with their customers. At last I would like to thank my internal supervisors Ariane von Raesfeld and Bjorn Kijl at the University of Twente for their advice and support in this research.

Dennis Schreinders, Enschede, June 2019

ABSTRACT

Because of the rapid technological progress, the complexity within the manufacturing industry have steadily increased. Where new trends and catchwords such as digitalization, the internet of things (IoT), internet of services (IoS) and cyber-physical systems (CPS) become more and more relevant, Germany, launched the so-called “Industrie 4.0”. This initiative in 2011 is part of its high-tech strategy, introducing the idea of a (fully) integrated industry. To create a networked and agile integrated value chain, company borders need to be crossed and logistics should be involved. With that, major challenges arise. For a lot of companies (especially SME’s), the increase in complexity leads to uncertainty on the overall impact Industry 4.0 has on their business model. With this uncertainty, a lack on concretization towards the implementation of industry 4.0 rises. To prepare these companies for implementing industry 4.0 in the nearby future, further implementation steps need to be assessed. Hence, this research aims to give these companies a first step on implementing the concept of Industry 4.0, by exploring the field of Industry 4.0 in collaborative settings within the logistic domain. Theory shows that this could best be executed by exploring the collaborative environment. Here the experience, drivers, barriers and partner preferences are discussed regarding Industry 4.0 in collaborative settings. These elements were explored by a multi-method design. By interviewing five top management positions within the logistic domain of the glass industry, the individual insights on their company’s insights towards the research topic became revealed, while a focus group with four top management practitioners within the logistic domain of the retail industry provided collective insight. Analysis of the exploration shows several important insights. First of all, the analysis reveals that within the logistic domain there is little to no experience when it comes to Industry 4.0 in collaborative forms. One best case stood out and provided a clear difference in the analysis of the elements. For example, the analysis shows that respondents with less experience tend to have an internal focus instead of an external focus and do not see a link between sustainability and Industry 4.0, while the case with experience did see a link and had a more external focus. Moreover, the analysis shows that the low level of digitalisation, bounded rationality and the missing of a solid business case keep companies with less experience from engaging with Industry 4.0 collaborations. A lot of companies do not yet feel ‘ready’ to achieve the idea of a fully integrated industry (Industry 4.0). Based on the results an alternative conclusion suggest that a lot of companies have a common misunderstanding towards Industry 4.0 in the context of possibilities. Ultimately, the paper suggests learning from experienced cases and foresees a huge potential for platform-based collaborations, even in domains where unexperienced companies do not see a link.

Keywords: Industry 4.0, supply chain collaboration, logistics, digitalisation

CONTENT

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

In recent years, the complexity and requirements in the manufacturing industry have steadily increased. Factors such as growing international competition, increasing market volatility, demand for highly individualized products and shortened product life cycles present serious challenges to companies (Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S., 2013). While the complexity in the industry increases, it also opens new doors for a range of new business potentials and opportunities because of the rapid technological progress. According to Hofmann, E., & Rüsch, M. (2017), trends and new catchwords such as digitalization, the internet of things (IoT), internet of services (IoS) and cyber-physical systems (CPS) are becoming more and more relevant.

Against this rapid technological progress and new business potentials, Germany, launched the so-called "Industrie 4.0" initiative in 2011 as part of its high-tech strategy, introducing the idea of a (fully) integrated industry (Barreto, L., Amaral, A., & Pereira, T., 2017). Since the introduction, Industry 4.0 has gained more importance, also beyond the German-speaking area, and has even been listed as a main topic on the 2016 World Economic Forum's agenda. By introducing the so-called fully integrated industry, it refers to integration between all business processes in the value chain across hierarchical levels and company boundaries (Liao, Deschamps, Loures, & Ramos, 2017). A definition of industry 4.0 that is in line with the idea of a fully integrated industry and illustrate the importance of crossing company boundaries both horizontal as vertical, will be used for this research: "Recent technological advances where the internet and supporting technologies (e.g. embedded systems) serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organizational boundaries to form a new kind of intelligent, networked and agile value chain." (Schumacher, Erol, & Sihn 2016).

One way to create a networked and agile value chain, is by involving logistics. In fact, Hofmann et al. (2017) argue that Industry 4.0 in its pure vision can only become reality if logistics is capable of providing production systems with the needed input factors at the right time, in the right quality and in the right place. But also in logistics there are big challenges rising because of industry 4.0. A two-dimensioned logistic oriented industry 4.0 model implies that there are three customer value components expected from industry 4.0: Value of availability, value of digital integration and value of digital servitization (Hofmann et al., 2017). Whereas the value of digital integration rises through a preamble transparency of the supply chain. Barreto et al. (2017) acknowledges this and mentions that industry 4.0 challenges might require technological changes such as: high need for transparency (supply chain visibility) and integrity control in the supply chains.

So, based on industry 4.0 studies, transparency in the supply chain can result in value of digital integration that creates customer value. "To overcome problems regarding the vision of industry 4.0, new methods and tools are needed to provide guidance and support to align business strategies with operations." (Schumacher et al., 2016). A way to call upon transparency, or also-called supply chain visibility, is by collaborating and crossing company boundaries (Schumacher et al., 2016; Hofmann et al., 2017; Barreto et al., 2017). For example, a big consultancy firm Capgemini, shares this thought and explains in a whitepaper the concept of a control tower. Control towers are cross-divisional organizations with system integrated "information hubs" that provide Supply Chain Visibility (Capgemini, 2011). According to

Vasconcelos, & Kaminski (2014) Control Towers are typically set-up to monitor, measure, manage transport and manage inventory movements across the supply chain. This requires collaboration on horizontal and vertical level. “Regarding the supply chain, the digital transformation and the use of intelligent and collaborative systems will make the supply chain smarter, more transparent and more efficient in every stage.” (Barreto et al., 2017).

1.1 Problem statement

Although the industry 4.0 concept is there, the realization of it on SME scale has not found its start. (Müller, Buliga & Voigt, 2017; Hofmann et al., 2017). Emons group is a small to medium size logistic service provider, providing mostly logistic services to the glass and retail industry. Recognizing the opportunities industry 4.0 has, they are willing to collaborate vertically based on industry 4.0 theory to raise supply chain visibility. With these solutions they seek to create customer value. This is line with the logistic industry 4.0 model as it concentrates on the mentioned ‘value of digital integration’, see Figure 1. (Hofmann et al., 2017). Although the idea is there, Emons is still seeking concrete fields of action in collaborating. They find difficulties with connecting to their customers on this particular subject.

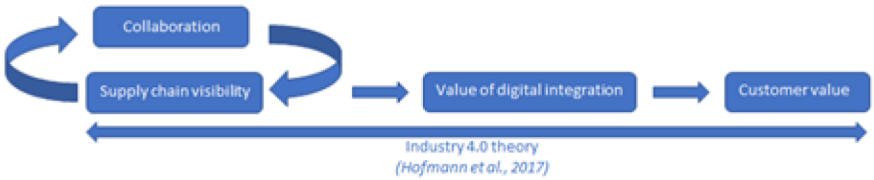


Figure 1: Situation sketch

Emons, as a SME, is not the only company that deals with this problem. By forming this far reaching industry 4.0 vision, it is obvious that it will lead to an increased complexity of processes on the micro and macro level (Schuh, Potente, Varandani, & Schmitz, 2014). This increase in complexity can lead to uncertainty. Schumacher et al. (2016) acknowledge this by mentioning that especially small- and medium sized companies are uncertain about the financial effort required for the acquisition of such new technology and the overall impact on their business model. Müller et al. (2018) elaborate more on these impacts in business models. For SME’s that are internally motivated to perceive a potential for themselves through industry 4.0 while acknowledging their current unpreparedness for implementing new technologies, industry 4.0 does not have an impact on their business models at present. Yet changes are envisioned. Müller et al. (2018) call this group “Preliminary stage planners” and expects that their motivation will lead them to industry 4.0 implementation in the mid- to long-term. In this context, the lack of concretisation towards industry 4.0 for SME’s corresponds with the unpreparedness for implementing new technologies of preliminary stage planners in industry 4.0 context. Considering the internal motivation of Emons and the lack of concretisation towards industry 4.0, Emons can be seen as such a “Preliminary stage planner”.

For implementing industry 4.0 technologies in logistics, company borders need to be crossed. (Schumacher et al., 2016; Hofmann et al., 2017; Barreto et al., 2017). Crossing company borders means collaborating closely with partners. For example, to create supply chain visibility. (Schumacher et al., 2016). Also, on the research agenda of smart industry, one of the key action points is collaboration. (Smartindustry.nl, 2014). Collaborations need to be formed to eventually implement industry 4.0 technology in logistic context. (Hofmann et al., 2017). To prepare preliminary stage planners on implementing industry 4.0 technology in the nearby future, exploring the collaborative network about collaborating in this context could be a first step. Palmer et al. (2012) describe in their collaboration framework the first step of collaboration as exploring. Although the paper of Palmer et al. (2012) does not focus collaborations in industry 4.0 context, it does seem to fit in with the paper of Müller et al. (2018) who urge for qualitatively assessing the implementation steps of Industry 4.0 in SMEs as further research directions. One of these implementations steps can be exploring the field of collaboration in industry 4.0 settings of their collaborative network.

1.2 Significance of topic

While the literature mentioning the key arguments for SME's not engaging with industry 4.0 relevant solutions and not finding concrete fields of actions upon this theme, solutions are rather left unspoken. "SME's seem to find problems in determining their state-of-development with regard to the Industry 4.0 vision and therefore fail to identify concrete fields of action, programs and projects." (Schumacher et al., 2016). Exploring the field of collaboration in industry 4.0 settings of the collaborative network of SME's finds his importance here, as it can be seen as a first step towards implementation (concretisation) of industry 4.0 on the mid- to long-term for SME's in the logistic sector. Also, academic investigation into Industry 4.0 extensively focuses on large enterprises (Arnold et al., 2016, Radziwon et al., 2014) and only marginally on SMEs (small and medium-sized enterprises) (Schmidt et al., 2015, Müller et al., 2018). This while SMEs provide a fruitful research sample, as those represent over 99% of the companies located in the EU and hire between 50 and 70% of the full time equivalent of persons employed. (Müller et al., 2017). From an empirical point of view, looking at the case of Emons, the importance can be found in that they can adjust their strategy towards collaborating in industry 4.0 settings to the exploration of their collaborative environment. Therefore, this paper tends to answer the following research question:

What insights for logistic SME's come forward when exploring collaboration in industry 4.0 settings of their collaborative network?

Giving the lack of literature on solutions for SME's in logistics that are willing to collaborate in industry 4.0 settings but fail to concretise it, this research aims to give these SME's a first step on implementing industry 4.0 technology on the mid- to long-term. With this first step insights about their collaborative network on collaborating in industry 4.0 settings will be feasible.

Related to the background, this research focusses on collaborations in the logistic industry based on industry 4.0 settings where idealistically companies focus on creating supply chain visibility by system integration, crossing company boundaries and creating forms of 'information hubs'. Within this paper, the terms 'collaboration', 'cooperation', 'partnership', 'alliance' and 'collaborative relationship' are used interchangeably. This is in accordance with the papers of Verstrepen, Cools, Cruijssen & Dullaert (2009) & Martin, Verdonck, Caris, & Depaire (2018) which are most closely related to this research work.

1.3 Method

This research is a single case study. Emons is a SME working in the logistic industry. There logistic services are focussed on the glass and retail industry. To explore the field of collaboration in industry 4.0 context of the collaborative network of a SME, the glass industry and retail industry will be used as units of analysis. By analysing different companies from a different industries, customers and non-customers, a general view/exploration on the field of collaboration towards industry 4.0 tends to arise for this single case. As said before, these scoping decisions are further discussed in section 3.1.

Furthermore, a multi-methods research approach contributes to understand the attitude of different customers towards collaborations in industry 4.0 settings. Semi-structured qualitative interviews with five top management practitioners within the glass industry seek to provide individual insights on their company's insights towards the research topic. Furthermore, a focus group with four top management practitioners from different companies within the retail industry seeks to provide a collective insight on the industry's thoughts towards collaborations in industry 4.0 settings. How to explore the field of collaboration in industry 4.0 context of a collaborative network, is a theoretical question that will be answered in the theoretical framework. This forms the content of the semi-structured interviews and focus group.

1.4 Reading guide

The research is structured as follows. Chapter 2 discusses the theory that is related to this research and ends with a design on how to explore towards this particular research topic. Chapter 3 discusses the methodology used for this research. Also, the reliability and validity of the research will be reflected. In Chapter 4 the results of this research will be presented. In Chapter 5, there is room for discussion where conclusion will be formed and limitations and recommendations for the research will be pointed out. All references can be found in Chapter 6. Additional information can be found in Appendices 1 till 7, whereas the planning can be found in Appendix 7: Planning.

2 THEORETICAL FRAMEWORK

The theoretical framework gives overview of the current literature in relation to industry 4.0 and collaborations. This results in forms like supply chain visibility, collaboration studies and theories about partner selection. Therefore, this chapter suggests integration of the concepts to achieve a common understanding serving further analysis of the research. The methodology of literature review is discussed beforehand. At last, a research framework is established based on the integration between the different theories where also some propositions will be argued linked to the research question.

2.1 Methodology of literature review

To acquire background knowledge on the subject and display the key papers related to, a literature review is executed in a systematic way (Webster and Watson, 2002). This means that first, search assignments are determined. Secondly, inclusion and exclusion criteria are stated. These criteria create a scope and are used to shorten the list of references that are obtained using the search assignments. Thirdly, the search assignments are executed, and duplicates are removed from the results. Fourthly, the articles are examined using the inclusion and exclusion criteria. Fifthly, the shortened list is read and articles that are not valuable are removed. Also, using backwards reading, other interesting articles are added. Lastly, the concepts are merged and used in the discussion below.

2.1.1 NARROWING DOWN THE LITERATURE

Search assignments and their purpose in the literature review are:

Search term	Purpose
"Supply chain visibility" AND "industry 4.0" AND "SMEs"	To learn about supply chain visibility based on industry 4.0 principles and where SME's are discussed.
"Control tower" AND "SMEs" logistics industry 4.0	To learn about industry 4.0 practices where SME's are considered and where logistics and industry 4.0 are relevant themes.
"Supply chain orchestration" and logistic service providers	To learn about orchestrating a supply chain where logistic service providers are involved.
"Industry 4.0" AND "collaboration" AND "implementation" AND "SME's"	To learn about industry 4.0 in forms of collaboration and implementation on SME level.
"Partner selection" AND "collaboration"	To learn about partner selection in general to create collaboration forms.
"Partner selection" AND "logistics"	To learn about partner selection in logistic settings.

Table 1: Search terms

Inclusion criteria	Exclusion criteria
Include if a work serves the purpose mentioned above.	Exclude if the work discusses the psychological part of industry 4.0.
Include if a work comes up with other practices than control towers.	Exclude if the work discusses other type of control towers (like telecom networks control towers or control towers in the aviation industry).
	Exclude if studies are published before 2000 (Except for partner selection studies), because they are deemed to be outdated for identifying a gap in research.

	Exclude if the work discusses the manufacturing side of industry 4.0 instead of the logistic part.
	Exclude if work concentrates on the sustainable part of industry 4.0.
	Exclude if the performance of supply chains in general is examined.
	Exclude if the work discusses the government of Korea (found a lot of works in this area that are not relevant).

Table 2: Search criteria

The literature review yielded the following results. With the search terms and criteria, Google scholar and LISA were examined. They provided a total of 378. After removing all the duplicates, 260 remained. These articles were scanned and assessed using the criteria by looking at the title and reading the abstract. By excluding irrelevant papers, 45 remained for reading. After having read these articles up to the point where key findings could be extracted, 27 remained. With snowballing techniques, 11 more studies were added. This resulted in a total of 38 papers that were included in the research and will be seen as the key articles that are central to this study.

Articles	Quantity	Category
Francis, (2008); Somapa, Cools, & Dullaert (2018); Bartlett, Julien, & Baines (2007); Barratt & Oke (2007); Morgan, Richey JR., & Ellinger (2018); Kaipia, & Hartiala (2006); Vanpoucke, Vereecke & Muylle (2017)	7	Supply chain visibility (characteristics, advantages, measurement techniques, frameworks, etc.)
Co & Barro (2009); Dalmolen, Moonen & van Hillegersberg (2015); Struiwigh (2012); Barratt (2004)	4	Supply chain collaboration (Characteristics, Frameworks & barriers)
Trzuskawska-Grzesińska (2017); Yan, Tan, Koh, Tan & Zhang (2012); Alias, Goudz, Jawale & Noche (2015); Vasconcelos & Kaminski (2014)	4	Control towers (Business examples, definitions, explaining and business models for implementing)
Brettel, Friederichsen, Keller & Rosenberg (2014); Müller, Buliga & Voigt (2018); Masdefiol, del Mar & Stävmo (2016); Liao, Deschamps, Loures & Ramos (2017)	4	Industry 4.0 & reasoning for and against
Barreto, Amaral & Pereira (2017)	1	Industry 4.0 & supply chain visibility
Kazantsev, Pishchulov, Mehandjiev, Sampaio & Zolkiewski (2018); Ganzarain & Errasti (2016); Kagermann (2015)	3	Industry 4.0 & collaboration & barriers and guidelines
Nieuwenhuize (2016); Hofmann & Rüsch (2017); Schumacher, Erol & Sihn (2016); Strandhagen, Alfnes, Strandhagen & Vallandingham (2017)	4	Industry 4.0 & logistics & implementation
Schuh, Potente, Varandani & Schmitz (2014)	1	Industry 4.0 & SMEs in particular
Bronder & Pritzl (1992), Brouthers K, Brouthers L & Wilkinson (1995), Eisenhardt & Schoonhoven (1996), Whipple & Frankel (1998)	4	Partner selection in general
Audy, Lehoux, D'Amours & Rönnqvist (2012), Naesens, Gelders & Pintelon (2009), Schmoltzi & Wallenburg (2011), Palmer, Saenz, van Woensel, & Ballot (2012), Van Breedam, Krols & Verstrepen (2005), Verstrepen, Cools, Cruijssen & Dullaert (2009)	6	Partner selection in logistic settings

Total:	38	

Table 3: Key articles

2.2 Industry 4.0

The first interesting topic to discuss is industry 4.0. According to Hofmann, E., & Rüsch, M. (2017), trends and new catchwords such as digitalization, the internet of things (IoT), internet of services (IoS) and cyber-physical systems (CPS) are becoming more and more relevant. Against this rapid technological progress and new business potentials, Germany, launched the so-called "Industrie 4.0" initiative in 2011 as part of its high-tech strategy, introducing the idea of a (fully) integrated industry (Barreto et al. 2017). According to experts from industry and research, the upcoming industrial revolution will be triggered by the Internet, which allows communication between humans as well as machines in Cyber-Physical-Systems (CPS) (Brettel et al., 2014). Figure 2 shows an example of a CPS. It has been listed as a main topic on the 2016 World Economic Forum's agenda. A joint report by the Fraunhofer Institute and the industry association Bitkom, shows the huge potential of industry 4.0 and said that German gross value can be boosted by a cumulative 267 billion euros by 2025 after introducing Industry 4.0. Here we only discuss Germany. If you would spread this over world figures it would be tremendous.

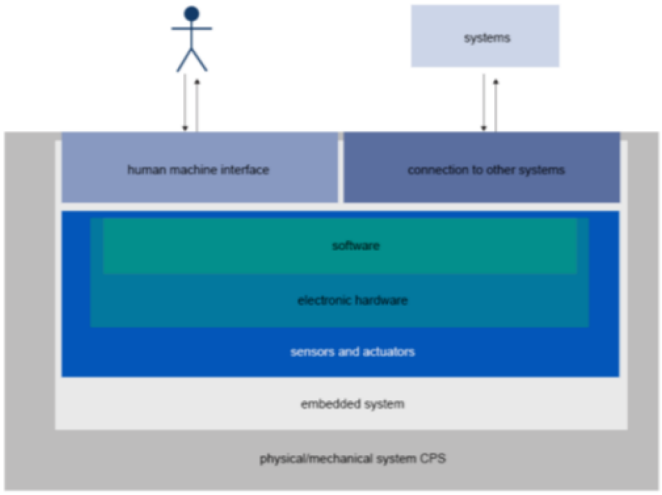


Figure 2: Interaction between humans and machines via CPS (Brettel et al., 2014)

The core focus of industry 4.0 find his way in the idea of a fully integrated industry. By introducing the so-called fully integrated industry, it refers to integration between all business processes in the value chain across hierarchical levels and company boundaries (Liao, Deschamps, Loures, & Ramos, 2017). A definition of industry 4.0 that is in line with the idea of a fully integrated industry and illustrate the importance of crossing company boundaries both horizontal as vertical, will be used for this research: "Recent technological advances where the internet and supporting technologies (e.g. embedded systems) serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organizational boundaries to form a new kind of intelligent, networked and agile value chain." (Schumacher, Erol, & Sihn 2016). Crossing company borders is also underlined by Brettel et al. (2014) as they mention that within collaborative networks, simulation and modelling the impact of process steps on products need to be carried out across company borders. However, the collective setup of simulation chains requires an infrastructure, which enables the entities to integrate their data between heterogeneous simulations.

2.2.1 INDUSTRY 4.0 AND LOGISTICS

Although we see the industry 4.0 literature mostly focussing on the manufacturing industry, the logistic industry finds his way in the topic also. In fact, Hofmann et al. (2017) argue that Industry 4.0 in its pure vision can only become reality if logistics is capable of providing production systems with the needed input factors at the right time, in the right quality and in the right place. Which falls in place when considering the urge for crossing company borders (Liao et al., 2017; Brettel et al., 2014; Schumacher et al., 2016). Therefore, some studies refer to the term logistics 4.0. "Logistics 4.0 can be summarized as the optimization of inbound and outbound logistics which must be supported by intelligent systems, embedded in software and databases from which relevant information is provided and shared though Internet of Things (IoT) systems, in order to achieve a major automation degree." (Strandhagen et al., 2017). But also in logistics there are big challenges rising because of industry 4.0. Logistics 4.0 might require for example a high need for transparency (supply chain visibility) and integrity control (right products, at the right time, place, quantity, condition and at the right cost) of the supply chain (Barreto et al., 2017; Strandhagen et al., 2017; Macaulay, Buckalew & Chung, 2015). This high need for transparency is necessary to create a fully integrated industry by crossing company borders. This raises the importance of logistics adapting to industry 4.0, as they have the chance to follow up on the need for transparency. That industry 4.0 is the main topic of one of the world's biggest logistic fair in München next June stresses this out even more.

The importance of logistics adapting to industry 4.0 is framed by Hofmann et al. (2017) as they suggest a two-dimensioned logistic oriented industry 4.0 model. This model implies that there are three customer value components expected from industry 4.0 in logistics: Value of availability, value of digital integration and value of digital servitization. A visual representation of this model is shown in Figure 3.

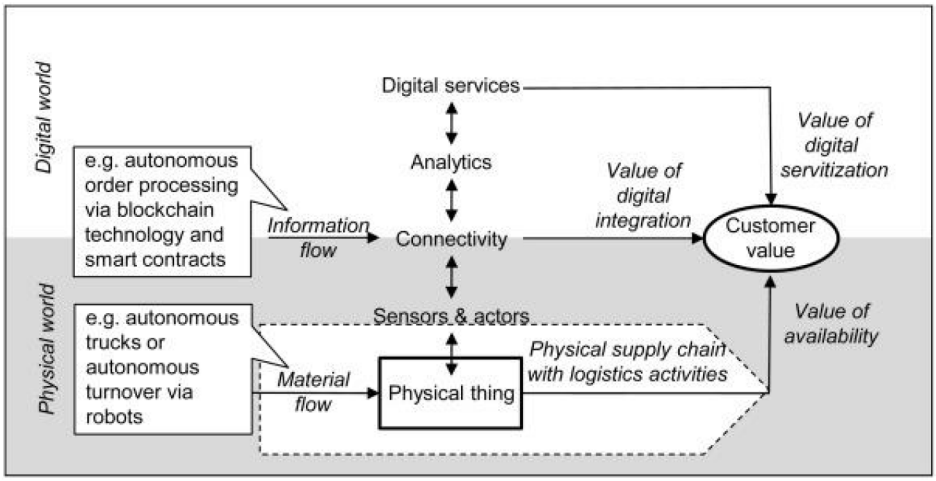


Figure 3: Logistic oriented industry 4.0 model (Hofmann et al., 2017)

The three customer values arise through two 'worlds', the physical and the digital world. Hofmann et al. (2017) expects that industry 4.0 can deliver customer value through the physical world by using for example autonomous trucks or robots. Through the digital world Hofmann et al. (2017) expect that blockchain and smart contracts will deliver customer value. These IT-based service options going beyond the simple distribution of products or physical services ("value of digital servitization"). "The data itself creates value outside the original use case ("sensor as a service")." (Hofmann et al., 2017).

As a third option, the two worlds together can deliver a very important customer value. This is what Hofmann et al. (2017) call the value of digital integration, whereas the value of digital integration rises through a preamble transparency of the supply chain. Barreto et al. (2017) acknowledge this by mentioning that the emerge of industry 4.0 technology requires for transparency (supply chain visibility). "Furthermore, order processing systems are interconnected, facilitating seamless business executions (e.g. object self-service, remote usages or condition monitoring)." (Hofmann et al., 2017). The interconnecting area corresponds with the paper of Müller, Buliga & Voigt (2018) that emphasize that Industry 4.0 encompasses three dimensions, namely high-grade digitization of processes, smart manufacturing, and inter-company connectivity. The last dimension is identical and shows the importance of the urge to cross company borders when considering industry 4.0 theory.

2.2.2 SUPPLY CHAIN VISIBILITY

The definition of supply chain visibility (SCV) is difficult to describe properly. Francis (2008) elaborated a literature review on the definition of SCV where at least 20 of them passed by. The definition that describes SCV on both strategic as operational level will be used for this research: "supply chain visibility means that important information is readily available to those who need it, inside and outside the organization, for monitoring, controlling and changing supply chain strategy and operations, from service acquisition to delivery." (Schoenthaler, 2003). According to Holweg, Disney, Holmström & Småros (2005) the common goal of supply chain collaboration is to create a transparent, visible demand pattern that paces the entire supply chain. Which aligns supply chain visibility with collaboration.

Somapa, Cools, & Dullaert (2018), tend to subdivide SCV in three characteristics that can be measured: accessibility of the information, quality of the information and the usefulness of the information. Important factors for companies not engaging with supply chain visibility other than miscommunication of the definition (Francis, 2008), are mentioned by a lot of articles. Poor data quality, trust issues, lack of scalable technology and the unavailability of technology by SMEs are the most mentioned barriers. (McCrea, 2005; Songini, 2000; Huddleston, 2002) Kaipia & Hartiala (2006), react to these barriers as they come up with five proposals for improving SCV. "They suggest that only information that improves supply chain performance should be shared, demand-supply planning processes must be stabilized and synchronized, different demand data sources should be used in parallel, customer collaboration offers a wider view to demand, and that suppliers' need for demand information differs from those of downstream actors." (Kaipia et al., 2006).

The importance of SCV in a supply chain can be confirmed by an article of Bartlett, Julien, & Baines (2007), whereas their research shows that creating SCV improves the overall supply chain performance. Although the importance of SCV is well understood, Barratt & Oke (2007) put the term into perspective as their research shows that the level of visibility across different external linkages differs considerably, based on various contributing factors which are both technology and non-technology based.

2.2.3 CONTROL TOWERS

A way to create supply chain collaboration and SCV in new industry 4.0 settings in the logistic industry is by making use of a control tower concept. As for SCV, giving a definition for control towers is hard. The

most revealing definition is given in a whitepaper by Capgemini: “A central hub with the required technology, organisation, and processes to capture and use supply chain data to provide enhanced visibility for short- and long-term decision-making that is aligned with strategic objectives.” (Capgemini, 2017). Important points within the definition are a central hub and the requirement of technology, organisation and processes. When looking at technology, IT innovation is very important. “IT interfaces are necessary because the control tower uses real-time data from existing transactional systems in order to integrate processes and tools across the end-to-end supply chain.” (Bleda 2014). Looking at the future, Trzuskawska-Grzesińska (2017) propose three options for manufacturers to work with control towers: develop their own control tower to control own conversion processes, offer control towers as a service (e.g. within 4PL service package), or purchase the control tower service from a specialized service provider.

Also, Alias, Goudz, Jawale & Noche (2015) present a business model canvas that has been developed to examine possible ways of exploiting the potential of Future-Internet-based logistics control towers in the transportation and logistics domain. Both papers (Yan et al. 2012; Alias et al. 2015) can be used for designing a control tower. Although this research does not aim to design a control tower in logistics the concept can be useful as a concrete example of an industry 4.0 solution in logistics.

2.2.4 COLLABORATION AND INDUSTRY 4.0

When crossing company borders, collaboration is necessary. Supply chain collaboration has been viewed as a business process whereby two or more supply chain partners work together toward common goals and achieve more mutual benefits than can be achieved by acting alone. (Cao & Zhang, 2013; Manthou, Vlachopoulou & Folinas, 2004; Sheu, Yen & Chae, 2006). Kagermann (2015) shows that one of the two key instruments for enhanced value creation in the Age of Industry 4.0 is platform-based collaboration. Platform-based collaboration focusses on integrations across company borders based on data driven platforms. To create data driven platforms, information/data needs to be shared. Sharing information is confirmed by Ellram (1995) that includes the sharing of information along with sharing of risks and rewards. Connecting companies by data driven platforms agrees upon Muller et al. (2018) that mentions inter-company connectivity as dimension for industry 4.0. The inter-company connectivity corresponds again with the urge for supply chain visibility, as visibility can only arise while collaborating across company borders. (Brettel, Friederichsen, Keller & Rosenberg, 2014; Schumacher et al., 2016; Hofmann et al., 2017; Barreto et al., 2017).

Collaborations across company borders can reach in several directions. Liao et al. (2017) mention in their paper that integrations (horizontal, vertical and end-to-end) are the main research direction for industry 4.0 in the future. These integrations can be established by collaborating. Liao et al. (2017) mention three forms of integrations, namely: horizontal, vertical and end-to-end. Collaborations also has these directions. This research focusses mainly on vertical collaborations/integrations. In that context, Barratt (2004) describes different possibilities a company has when looking at a vertical collaboration in the supply chain. This is shown in Figure 4. The model is very useful in determining what possibilities a company has (although horizontal collaboration is not taken into account). Barratt (2004) also proposes that a segmented supply chain approach limiting collaboration to a small but potentially critical number of

partners raises the chances of a company's performance. Meaning that the number of partners a company wants to collaborate with is critical.

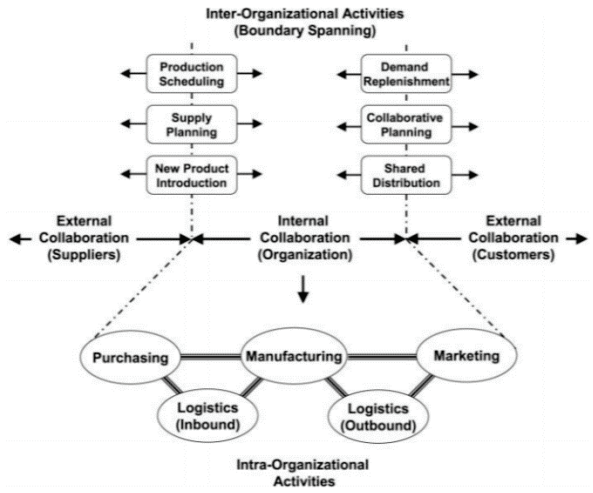


Figure 4: The scope of vertical collaboration (Barratt, 2004)

Also, the type of a particular relationship can be determined. Lambert et al. (1996) distinguishes five type of relationships, whereas the most weak relationship is called an arm's length and the strongest a vertical integration (see Figure 5). The model of Lambert et al. (1996) distinguishes the different partnerships based on basic vs complex products/services and short vs long term decision making. The most interesting types are the type 1 till 3 partnerships as the options like joint ventures and vertical integration are a step further than a typical collaboration. The type 1 relationship typifies itself as organisations that, on a limited basis, coordinate activities and planning. Usually on short-term planning. Type 2 has a more long-term planning, although not 'forever'. Multiple divisions and functions within the firm are involved in the partnerships. In type 3, organisations share a significant level of operational integration. Each party views the other as an extension of their own firm. Typically, no 'end date'. "Possible collaborations in industry 4.0 context, will mainly focus on sharing information by data platforms." (Kagermann, 2015). Based on this industry 4.0 focus, the model of Lambert et al. (1996) falls short. Although the urge of sharing data can be seen as a long-term planning, the relationship itself will not focus on sharing a significant level of operational integration but more on platform-based collaborations. (Schumacher et al., 2016; Hofmann et al., 2017; Barreto et al., 2017). Therefore, collaborations in industry 4.0 settings form a new type of relationship.

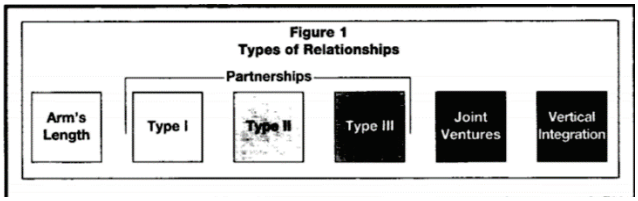


Figure 5: Type of relationships (Lambert et al. 1996)

2.3 Exploring collaboration in industry 4.0 settings

Although the idea of collaborating in industry 4.0 settings is there, SME's seem to find problems in determining their state-of-development with regard to the Industry 4.0 vision and therefore fail to identify concrete fields of action, programs and projects." (Schumacher et al., 2016). Palmer et al. (2012) describe in their collaboration framework the first step of collaboration as exploring. Although the paper of Palmer et al. (2012) does not focus on industry 4.0 collaborations, it does seem to fit in with the paper of Müller et al. (2018) who urge for qualitatively assessing the implementation steps of Industry 4.0 in SMEs as further research directions. Exploring the field of collaboration in industry 4.0 settings of the collaborative network of SME's can be seen as a first step towards implementation (concretisation) of industry 4.0 on the mid- to long-term for SME's in the logistic sector. But how can collaboration in industry 4.0 settings of the collaborative network from logistic SME's be explored, so that first insights for logistic SME's about concretizing industry 4.0 come forward?

The first thing we want to know is, what is exploring? Exploration can be seen as: "The activity of searching for something and finding out about something." (Salkind & Rainwater, 2003). Exploring the field of collaboration in industry 4.0 context encompasses finding out about collaboration in industry 4.0 context. If we want to explore/ find out about this particular subject, how do we do this? Literature does not suffice in a precise way to explore this. Palmer et al. (2012) name exploring the first step in forming a collaboration. They suggest identifying drivers and barriers as starting point for exploring. With drivers they mean the reasoning for wanting to collaborate and with barriers the reasons why they cannot do it. After identifying this, they call upon the process of selecting a successful partner. There are many studies concerning partner selection. To asses' potential partners, a company needs to determine the variables for its assessment. One of these criteria Palmer et al. (2012) mention is: collaborative environment. Here they asses four elements: Collaborative experience, Drivers, Barriers and Partner preferences. Although this is one of the five criteria they suggest for selecting a correct partner, it seems to encompass at least the exploration part they mention earlier in their collaboration framework: Drivers and Barriers. Apart of these 2, partner preferences are mentioned, which is usable in the second step of exploring according to their framework. The last element that the criterium 'collaborative environment' encompasses, is collaborative experience. Which is an interesting exploration element. Müller et al. (2018) call upon experience as a main factor for maturing in Industry 4.0 context. Against this reasoning, Ganzarain & Errasti (2016) came up with a three-stage maturity model to help companies determining their individual industry 4.0 vision. While creating experience the maturity grows.

So, can the field of collaboration in industry 4.0 context be explored by exploring the collaborative environment in industry 4.0 context? Exploring the collaborative environment encompasses drivers and barriers. This is the first step in the exploration phase of Palmer et al. (2012). The second step of the exploration phase is selecting potential partners on different assessment criteria, which is also being examined when exploring the collaborative environment. At last, exploring the experience in industry 4.0 context helps with determining the maturity of industry 4.0 of the specific unit of analysis (Ganzarain et al., 2016). Because literature does not suffice in exploring collaboration in industry 4.0 context of the collaborative network, alternatives need to be considered. Exploring the collaborative environment seems to fit in as the best alternative, as it fills in two needs of different papers about collaboration and industry 4.0 maturity.

2.3.1 COLLABORATIVE EXPERIENCE

Ganzarain & Errasti (2016) came up with a three-stage maturity model to help companies determining their individual industry 4.0 vision. The three-stage model is shown in Figure 6.

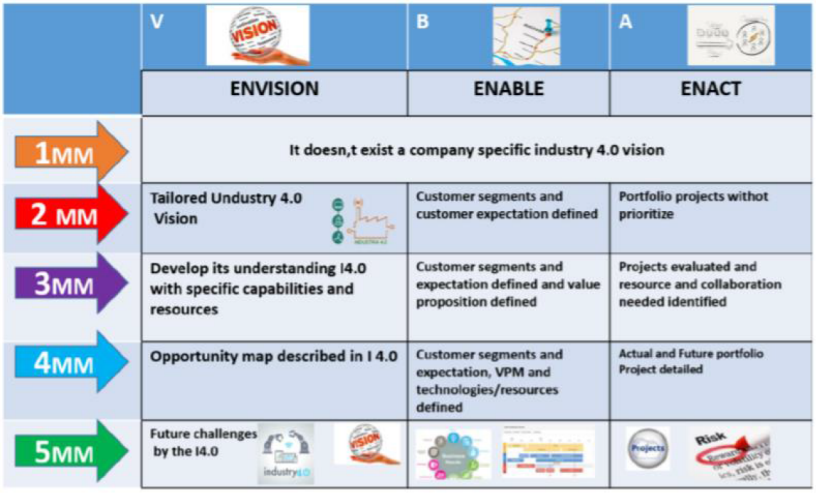


Figure 6: Maturity model to the industry 4.0 vision (Ganzarain et al., 2016)

Ganzarain et al. (2016) come up with the following three stages in maturity: envision, enable and enact. The envision stage is dedicated to defining a tailored Industry 4.0 vision, developing its own understanding general Industry 4.0 ideas with company specific capabilities and resources. As a follow up, the enable stage starts from a substantial Industry 4.0 vision and based on this vision, the company try to define the technology portfolio and capabilities needed to give support to the new product-service solutions identified in the previous stage. The last stage, the enact stage, turns this industry 4.0 specific strategy into concrete projects that are prioritized wisely.

Ganzarain et al. (2016) defined the model with the following levels, in order to apply the maturity model to implement Industry 4.0 scenario:

1. Initial: There doesn´t exist a company specific industry 4.0 vision
2. Managed: There exist a Roadmap of industry 4.0 strategy
3. Defined: Customer segments, value proposition and key resources defined
4. Transform: Transform the strategy into concrete projects.
5. Detailed BM: Transformation of Business Model

While this model is for an individual company to determine their own maturity towards industry 4.0, it looks a lot like project portfolio management maturity levels. For example, see Figure 7. The classic model of Gartner (2014) shows a lot of similarities with the model of Ganzarain et al. (2016). The similarities of the two maturity models is evidently found in the alignment of the strategy with the portfolios/projects further on when the maturity rises. Although the maturity levels are for determining a company's own level towards industry 4.0, it could also be very useful to determine another company's maturity towards it. When considering the collaborative experience in industry 4.0 context, the maturity could be a scale level for determining this. Also, the stage model of Müller et al. (2018) gives a clear understanding of manufacturing company's engaging with industry 4.0 (see Figure 8). Although this model focusses on manufacturing company's only, it does show an obvious maturity curve from traditional craft manufacturers to full innovative companies. Both the maturity model of Ganzarain et al. (2016) and the stage model of Müller et al. (2018) can be useful in analysing the collaborative experience. The model of Ganzarain et al. (2016), however, will be used as it is more detailed and providing more small steps in-between the stages.

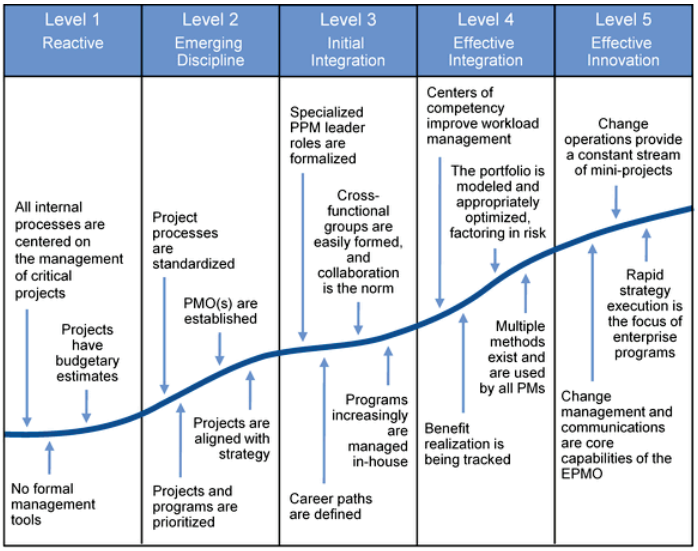


Figure 7: PPM maturity model (Gartner, 2014)

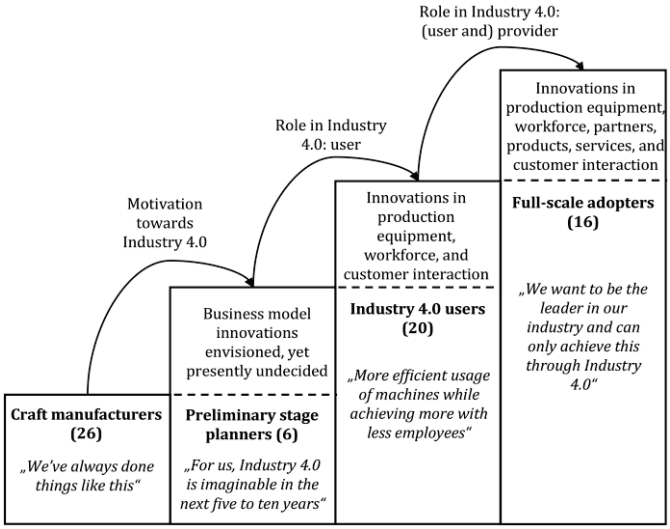


Figure 8: Stage model of manufacturing SME's in industry 4.0 context (Müller et al., 2018)

2.3.2 DRIVERS

Palmer et al. (2012) made an important contribution to the main drivers for collaboration, shown in Figure 9. The main driver for collaboration between logistic providers is cost reduction, but also demanding customers and service level are important. Although these drivers are not focussed on industry 4.0, they are focussed on collaboration in logistic context.

DRIVERS	VALUES
Cost reduction	4.6
Demanding customers	4.4
Service level	4.2
Increased differentiation	4.0
Increased competition	3.4
Increased regulation	3.4
Reduce CO2	3.2
Sustainability	3.0

TABLE 1: PERCEIVED IMPACT OF DRIVERS

Figure 9: Main drives for collaboration based on Palmer et al. (2012)

Müller et al. (2018) made an important contribution to the drivers for collaboration with industry 4.0. They suggest a difference between internally motivated and externally pressured for engaging with industry 4.0. Also seeing industry 4.0 in a user role or in a provider role, brings the motivations in a matrix model shown in Figure 10. Both the found drivers of Palmer et al. (2012) as the distinction between internally motivated or externally pressured can be used in analysing the drivers of collaboration in industry 4.0 context. Also seeing it from a user role, provider role or both can be a good way to analyse in cross-case conditions considering the relationship between the maturity and role within industry 4.0 found out by Müller et al. (2018). They are suggesting that seeing it from both a user as a provider role as a manufacturing company will raise the maturity towards industry 4.0. This can also be analysed.

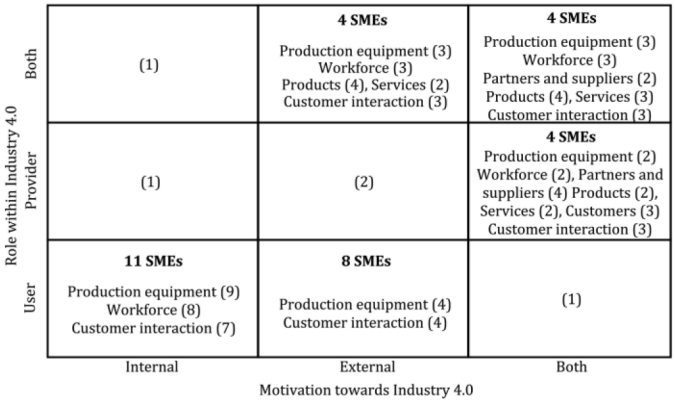


Figure 10: Motivation versus role in industry 4.0 (Müller et al., 2018)

2.3.3 BARRIERS

Barriers for not collaborating in industry 4.0 context or not are described by literature in abundance. Masdefiol, del Mar & Stävmo (2016) show that for SMEs not only the level the level of automation or the technological features will determine if the concept of Industry 4.0 is feasible for them, but also the business strategy and culture, as well as the product features and the leaders' mind-set. Schumacher et al. (2016) acknowledge this by mentioning that especially small- and medium sized companies are

uncertain about the financial effort required for the acquisition of such new technology and the overall impact on their business model. Alias et al. (2015) mention technological impediments and multiple sources of data not being available or combinable as possible reasons. “SME’s seem to find problems in determining their state-of-development with regard to the Industry 4.0 vision and therefore fail to identify concrete fields of action, programs and projects.” (Schumacher et al., 2016).

Kazantsev et al. (2018) found four barriers that prevent the uptake of collaborations in industry 4.0 settings especially for SMEs: trust, switching costs, knowledge deficits and bounded rationality. Here the focus is more on today’s knowledge that shine light on industry 4.0 in combination with SME’s.

Building upon the need for supply chain visibility (SCV), accessibility, quality and usefulness of the information are important elements for not engaging with the concept. (Somapa et al., 2018). Fourth, in SME context the quality of the information is even a more important factor for companies not engaging with SCV. Trust issues, lack of scalable technology and unavailability of technology are the other most mentioned barriers. (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006). Also, Alias et al. (2015) mention technological impediments and multiple sources of data not being available or combinable as possible reasons. Putting all the theory together, this leads to the following overview:

1. **Need for supply chain visibility** (Schoenthaler et al., 2003; Holweg et al., 2005; Somapa et al., 2018; Barreto et al., 2017; Strandhagen et al., 2017; Macaulay, Buckalew & Chung, 2015)
    - **Bad availability of information** (Somapa et al., 2018; McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006; Alias et al., 2015)
    - **Bad accessibility of information** (Somapa et al., 2018; Kaipa et al., 2006)
    - **Bad quality of information** (Somapa et al., 2018; Kaipa et al., 2006)
    - **Bad usefulness of information** (Somapa et al., 2018)

2. **Culture** (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006; Masdefiol et al., 2016; Kazantsev et al., 2018)
    - **Lack of trust** (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006; Kazantsev et al., 2018)
    - **No aligning business strategy** (Masdefiol et al., 2016)
    - **Missing key people/leaders’ mindset** (Masdefiol et al., 2016)
    - **Bounded rationality** (Kazantsev et al., 2018)

3. **Technological knowledge** (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006; Kazantsev et al., 2018; Alias et al., 2015; Masdefiol et al., 2016)
    - **Technological impediments** (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006)
    - **Lack of scalability towards technology** (McCrea, 2005; Songini, 2000; Huddleston, 2002; Kaipia & Hartiala, 2006; Strandhagen et al., 2017)
    - **Too low level of automation** (Masdefiol et al., 2016)

4. **Financial status** (Schumacher et al., 2016; Kazantsev et al., 2018; Strandhagen et al., 2017)

- **Too much financial effort** (Schumacher et al., 2016; Kazantsev et al., 2018; Strandhagen et al., 2017)
- **Switching costs** (Kazantsev et al., 2018; Strandhagen et al., 2017)
- **No solid business case/impact** (Schumacher et al., 2016)

These barriers can be used to analyse and compare with the found data when exploring barriers when collaborating in industry 4.0 context. Also, they can be used as conversation point later on when exploring and collecting data.

2.3.4 PARTNER PREFERENCES

There are many studies concerning partner selection. To asses' potential partners, a company needs to determine the variables for its assessment. A broad range of selection criteria is provided by literature. Hagedoorn (2006) implies that a partnership relationship becomes embedded at a certain point. This means that repeating a collaboration with a known partner firm is preferred over starting new collaborations with strangers. The reason for this is an increased familiarity and trust with known partners (Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010), which urges the need for trust within a possible partner. Besides familiarity and trust there are several other aspects that influence the partner search process.

The partner selection framework of K. Brouthers, L. Brouthers & Wilkinson (1995) mention four major forces in assuring success in finding a suitable partner: complementary skills, cooperative cultures, compatible goals and commensurate levels of risk. Here complementary skills can be considered as technological knowledge, however a way of testing this is not provided. In other words, these four major forces can also be categorised in strategic alignment, cultural alignment, technological alignment and operational alignment. Whereas Strategic alignment aligns with compatible goals, cultural alignment aligns with cooperative cultures, technological alignment aligns with complementary skills and operational alignment aligns somewhat with commensurate level of risk. In this way the assessment criteria of Emden, Calantone & Droge (2006) matches as they distinguish technological, strategic and relational alignment as assessment criteria for finding partners for new product development (see Figure 11). However this research focus solely on new product development, the assessment criteria could be useful. Especially if it matches other partner selection theory. Bronder et al. (1992) mention that finding the right partner is one of the most important success factors of a strategic alliance. For assessing partners, they also suggest that a company should focus on fundamental, strategic and cultural fits. With fundamental fits they aim at the mutuality of the possible partner, finding the right reasoning behind a collaboration. This can also be seen as a strategic element.

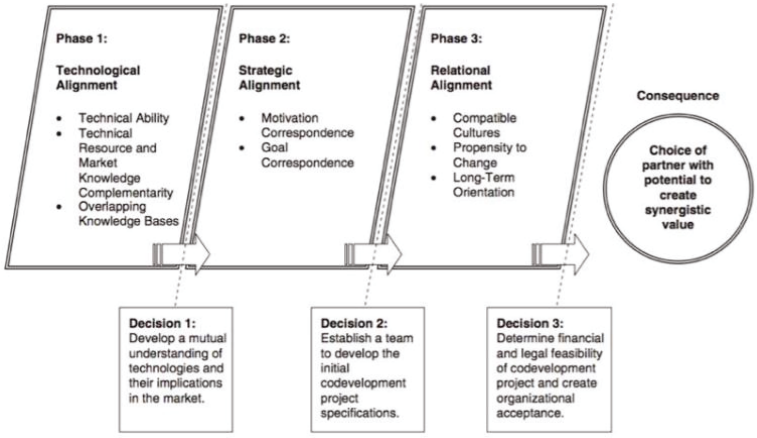


Figure 11: Partner selection for creating product advantage by collaboration (Emden et al., 2012)

Barratt (2004) discusses elements involving a successful collaboration between companies in a supply chain. He distinguishes three broad categories of elements: cultural, strategic and implementation elements, whereas the cultural and strategic elements lead to implementation elements as shown in Figure 12. So based on the cultural elements, both companies that collaborate should have the right trust, focus on mutuality rather than only themselves, are willing to exchange their information and are open in their communication. These cultural elements are in line with Palmer et al. (2012) that mention culture, trust and willingness to share data as the important factors for collaborating horizontally between logistic firms. Also, this corresponds to the paper of Dalmolen et al. (2015).

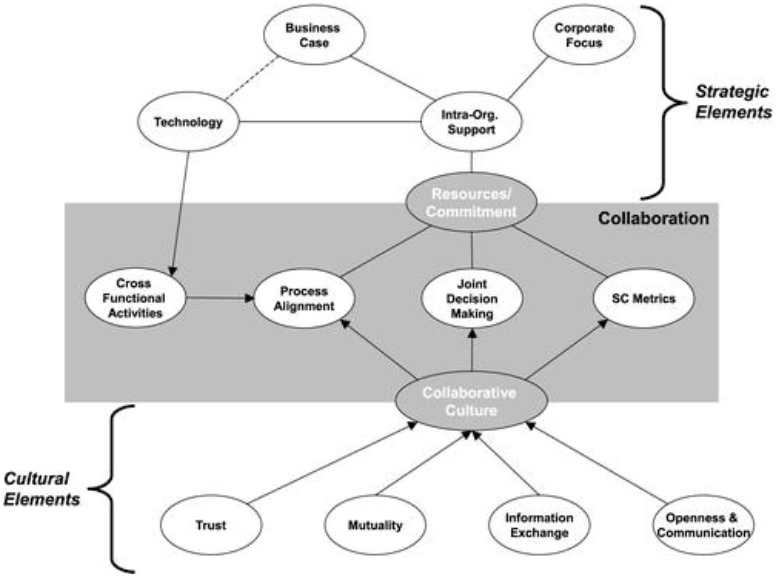


Figure 12: Elements of a collaboration (Barratt, 2004)

Based on the strategic elements mentioned by Barratt (2004), both companies that collaborate should provide intra-organisational support in two distinct forms. First, in the shape of initial and ongoing senior management support, and second, in terms of gaining the support of other parts of the organisation intro-organisational support and corporate focus. Also, companies have to see collaborations in the supply chain as their corporate focus, create a solid business case to win commitment and should carefully think about the technology being used in the collaboration.

Eisenhardt & Schoonhoven (1996) discuss in their paper elements that raise the likeliness of an alliance formation. One of their key findings is that companies that operate from a vulnerable strategic position are most likely to form a strategic alliance. With a vulnerable strategic position, they call for examples like emergent markets, innovative technologies and high competition. This awareness of innovative technologies is a particular important factor here, as SME's are dealing with the trend of industry 4.0, which raises again the importance of collaboration/alliances. So technological knowledge is an important factor, which agrees upon the paper of Emden et al., (2006). Second, Eisenhardt & Schoonhoven (1996) found out that top management characteristics also affected the rate of alliance formation. Large, experienced, and well-connected through former employers and high-level previous jobs formed alliances at higher rates. Such companies would be more likely to gain alliances if they needed them and to be offered attractive alliancing arrangements. Naesens et al. (2008) also pay attention to the importance of key people within a company by forming strategic alliances. One of the elements of a successful collaboration he distinguishes is key people.

While key people are one important factor Naesens et al. (2009) describe, they also mention several others. In their paper they tend to break down the evaluation of strategic fit between two companies into a hierarchical structure model (see Figure 13). Their model focusses on horizontal collaborations only. This is of course significantly different from vertical collaborations. (Naesens et al., 2009). The completion, importance and the relationship between the elements will differ between horizontal and vertical collaborations. (Naesens et al., 2009; Bronder et al., 1992). Still the elements themselves can be very useful. The subdivision of evaluating strategic fit in criteria is striking. Company characteristics, competitive advantage, internal processes and external parameters are laid-out. Especially the concrete elements that drive the criteria, is something other studies seem to lack. This model gives a more overall decision-making framework for evaluating potential partners.

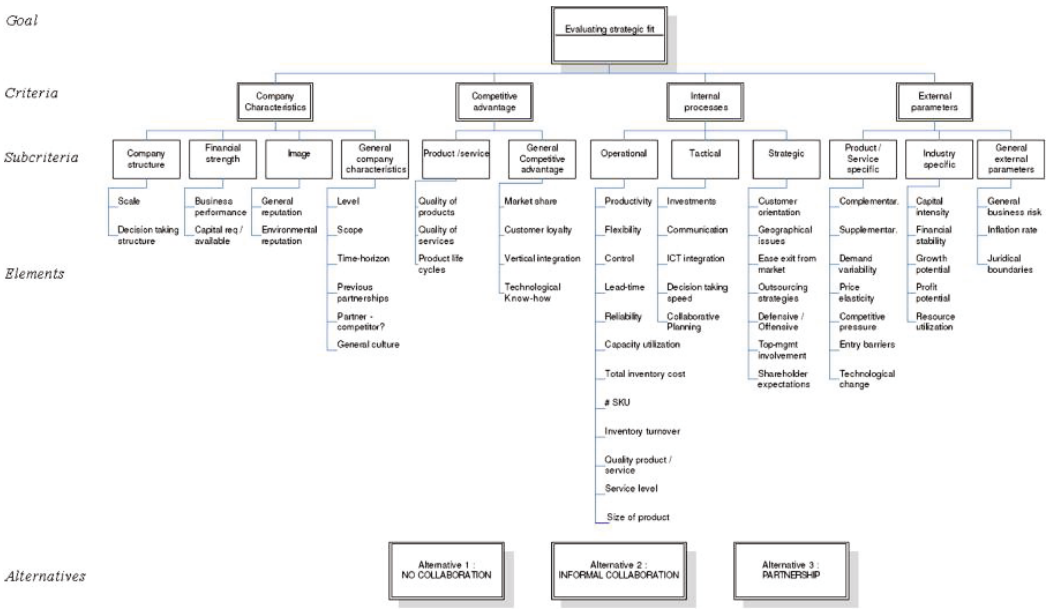


Figure 13: Hierarchical structure for evaluating strategic fit (Naesens et al., 2009)

The hierarchical structure model of Naesens et al. (2009) has been reconfigured by Palmer et al. (2012) in a CO3 paper. While Naesens et al. (2009) had 59 elements, the model of Palmer et al. (2012) has 35 (see

Figure 14). They reconfigured is based on other papers and their own data, interviewing and organizing focus groups with top sector logistic multinationals. Although this is still much and still focusing on horizontal collaborations, it does tend to focus on the most important elements considering a successful collaboration within the logistic sector. Also, the strategic fit has been subdivided into other criteria. Putting all the theory together, this leads to the following overview:

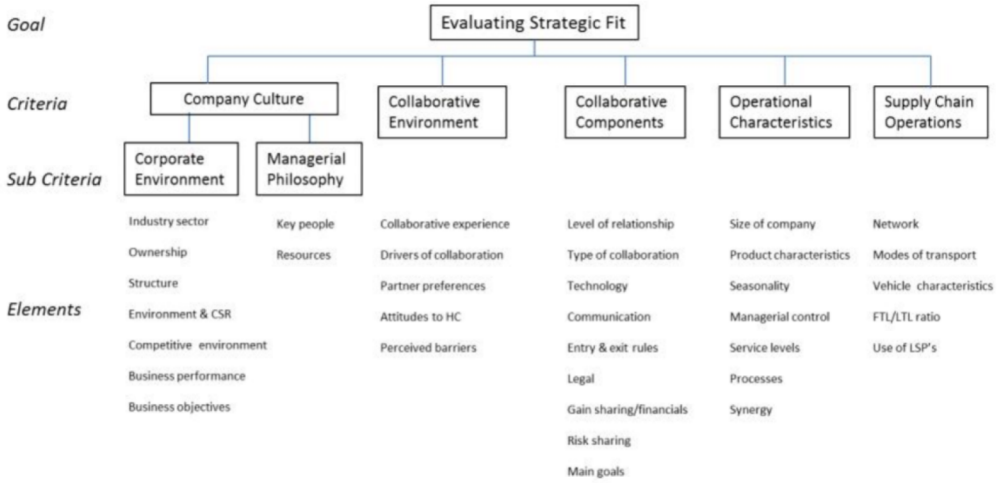


Figure 14: Hierarchical structure for evaluating strategic fit (Palmer et al., 2012 based on Naesens et al., 2009)

1. **Cultural/personal fit** (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004; Palmer et al., 2012; Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006; Brouthers et al., 1995)
    - **Trust** (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004; Palmer et al., 2012; Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006)
    - **Familiarity** (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010)
    - **Mutuality/ fundamental fit** (Brouthers et al., 1995; Bronder et al., 1992; Barratt, 2004; Emden et al., 2006; Naesens et al., 2008; Palmer et al., 2012)
    - **Top management characteristics/ key people** (Eisenhardt et al., 1996; Barratt, 2004; Naesens et al., 2009)
    - **Information exchange** (Barratt, 2004; Naesens et al., 2008; Palmer et al., 2012)
    - **Openness** (Barratt, 2004)

2. **Strategic fit** (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004; Palmer et al., 2012; Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006; Brouthers et al., 1995)
    - **Compatible goals/ corporate focus** (Brouthers et al., 1995; Barratt, 2004: Dalmolen et al., 2015; Naesens et al., 2009; Palmer et al., 2012)
    - **Commensurate levels of risk** (Brouthers et al., 1995; Palmer et al., 2012; Emden et al., 2006)
    - **Financial strength** (Naesens et al., 2009)

- **Business case** (Barratt, 2004; Dalmolen et al., 2015)
- **Intra-organisational support** (Barrat, 2004)

3. **Operational fit**
   - **Size of company** (Palmer et al., 2012)
   - **Product characteristics** (Naesens et al., 2009; Palmer et al., 2012)
   - **Service levels** (Naesens et al., 2009; Palmer et al., 2012)
   - **Processes** (Naesens et al., 2009; Palmer et al., 2012)

4. **Technological fit** (Eisenhardt et al., 1996; Brouthers et al., 1995; Bronder et al., 1992; Emden et al., 2006; Barrat, 2004; Dalmolen et al., 2015)
   - **Complementary skills** (Brouthers et al., 1995)
   - **ICT integration** (Naesens et al., 2009)
   - **Technological ability** (Emden et al., 2006; Barratt, 2004; Naesens et al., 2009; Palmer et al., 2012)
   - **Market knowledge** (Emden et al., 2006)

These partner selection elements can be used to analyse and compare with the found partner preferences when exploring partner preferences when collaborating in industry 4.0 context. Also, they can be used as conversation point later on when exploring and collecting data.

2.4 Exploration model

To explore the field of industry 4.0 in collaborative settings, several theories have been reviewed with the goal of finding a valid construct for measuring this specific topic. The reviewed theory revealed four main elements that seem to fit best: Experience, drivers, barriers and partner preferences. These four elements form together the collaborative environment in the paper of Palmer et al. (2012), that use this construct as part of a large model for analysing a potential collaboration partner. In these specific research settings, this literature review showed that the construct could be used as a way of exploring industry 4.0 in collaborative settings. Figure 15 shows the construct that will be used as research framework.

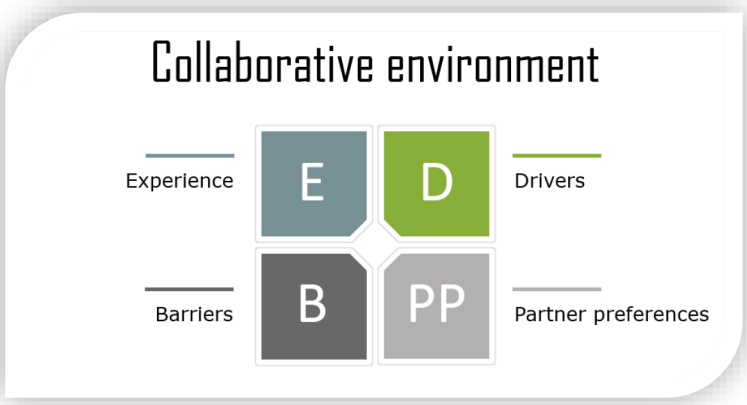


Figure 15: Framework for exploring Industry 4.0 in collaborative settings based on Palmer et al. (2012)

2.4.1 PROPOSITIONS

Related to the research question, some propositions can be made beforehand based on the research framework. Namely, several theories discuss direct or indirect a possible link between the different elements. First of all, Müller et al. (2018) discusses in an indirect way the connection between experience and drivers. Companies that have less experience in industry 4.0 tend to foresee only a user role within industry 4.0 and no provider role. Foreseeing only a user role can be seen as an internal motivation rather than external pressure, as these companies do not link industry 4.0 to other partners directly. Therefore, the first proposition is:

"Respondents that tend to have less experience in industry 4.0, have a more internal motivation towards the trend than feeling external pressured."

Second, as a more of a logical proposition, barriers will most probably be existent at companies where there is little to no experience. Kazantsev et al. (2018) do mention companies that are coping with scalability issues while having experience in industry 4.0, but most of the mentioned barriers are based on companies that are not engaging with industry 4.0. (Masdefiol et al., 2016; Kazantsev et al., 2018). Therefore, the following proposition arise:

"Respondents with little to no experience with Industry 4.0 tend to experience more barriers than companies with more experience."

Third, the theory section of barriers and partner preferences show a lot of similarities. For example, cultural/human based barriers (Kaipia & Hartiala, 2006; Masdefiol et al., 2016; Kazantsev et al., 2018) and preferring to have a cultural fit when looking for partners (Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006; Brouthers et al., 1995). Another example are technological barriers (Kazantsev et al., 2018; Alias et al., 2015; Masdefiol et al., 2016) and preferring to have a partner with a technological fit (Brouthers et al., 1995; Bronder et al., 1992; Emden et al., 2006; Barrat, 2004; Dalmolen et al., 2015). As all these similarities arise, the following proposition can be made:

"Respondents give similar answers to their observed barriers as their preferences when looking for a partner."

The general field of industry 4.0 in collaborative settings alongside the developed propositions are explored by a multi-methods design contributing to the research. The methodology will be further discussed in the following section.

3 METHODOLOGY

This chapter discusses the approach that is taken to perform the research. Every sub-section discusses a step within the research design. The research design, measurement instruments alongside the operationalisation of the research framework, units of analysis, the data collection procedures and the data analysis method will be discussed. Afterwards, a short assessment of the reliability and validity take place. At last, a summary of the methodology will be given.

3.1 Research design

This research aims to answer the following question:

What insights for logistic SME's come forward when exploring collaboration in industry 4.0 settings of their collaborative network?

To specify an approach for this research, the type of research first needs to be specified. The research tends to find deeper understanding about collaborations in industry 4.0 context of the collaborative environment. A research framework is proposed alongside argued propositions considering the relative broad research question. This demands for underlying reasoning and motivations, which leads to new or confirming ideas. This is an iterative process, which makes this research a qualitative research. "Qualitative research methods are useful for researching unexplored topics." (Britten, Jones, Murphy & Stacy, 1995). Exploring the collaborative environment with the four mentioned elements in the literature section is of an explorative nature, since it represents a topic where little scientific knowledge is available about the process that will be examined (Stebbins, 2001). Qualitative research methods are most often (not exclusively) appropriate to explore a conceptual model, while quantitative research is most often used to test a conceptual model (Verschuren & Doorewaard, 1995).

3.2 Measurement instrument

To explore the collaborative environment, a multi-methods research approach will be used. A multi-methods research approach contributes to understand the attitude of different customers towards collaborations in industry 4.0 settings. First of all, interviews will be used. Harrel and Bradley (2009) stated that researchers can use interviews for a variety of purposes, such as collecting information from individuals about their own practices, perception, attitudes, beliefs, or opinions. Three type of interviews are suggested in literature: Structured, semi-structured and unstructured. This research will use the semi-structured design. Harrel and Bradley (2009) stated that semi-structured interviews are often used when the researcher wants to delve deeply into a topic and to thoroughly understand the answers provided (p. 27). This design suits the research best as several topics, provided by the new framework, need to be covered to gain proper understanding on the research question. For this reason, an unstructured design would not suffice. A structured design would also be less appropriate as this research demands for underlying reasoning and therefore does not provide enough space for interrogating on specific topics.

Second, a focus group will be used. With a focus group information can be collected in a group, which gives another dimension than gathering information from individuals alone. "A focus group allows consumers to express clear ideas and share feelings that do not typically come out in a quantified survey or paper test. Because of the open conversation among group members, topics and discussions are freer

flowing and members can use comments from others to stimulate recall." (Harrel and Bradley., 2009). Observations would also be an interesting instrument, but due to various arguments this also seems out of bounds (time-limit, minimum sample size for observation).

The four elements (collaborative experience, drivers, barriers and partner preferences) that are named in the research framework, will be used as main topics for the semi structured interview design and focus group. However, partner preferences were not discussed during the focus group due to time limits. According to the literature, these elements fit in the best when exploring collaborating in industry 4.0 settings from a SME logistic perspective. An interview guide is used for the researcher as operationalisation of the elements and to make sure the list of topics will be covered. This interview guide can be found in Appendix 1: Interview guide. The focus group guide can be found in Appendix 2: Focus group guide. With the elements as main topics, the interpretation of them as well as underlying reasoning and prioritization will be questioned. The prioritization, however, is not discussed during the focus group due to time limits. The elements will be discussed with industry 4.0 context as standpoint. For example, control towers or creating some sort of SCV trough sharing data as mentioned in section 2.2.3.

3.3 Units of analysis

When wanting to conduct interviews, the units of analysis should be determined. In this case a specific unit of analysis is noticeable: Partners of (a) SME(s) operating in the logistic industry and possible partners of (a) SME(s) operating in the logistic industry. As this research found its ground at Emons, this research has the unique opportunity to get access to possible partners. This means the specific unit of analysis can be met. Although this unique opportunity is there, it should be taken into account that this are only the partners of one SME in the logistic industry. This makes this research a single case study. Emons also gave knowledge about companies that are not customers at the current moment. The interviews will be preferably held with the top-management positions of a partner or possible partner. This specific unit is chosen as these positions are most often involved or influential in the decision-making process of forming collaborations and technological solutions. (Eisenhardt et al., 1999).

The choice for sticking to only one case, has a couple of reasons. First of all, gaining access to this specific unit of analysis is hard. Finding another case (logistic SME) that is willing to collaborate on new theory and provides access to their partners for analysis is very unlikely to happen. Second of all, when just analysing different partners not from a case (like Emons) will not provide sufficient deeper knowledge on the subject. By analysing one specific case in the correct context, it will give the change of finding this deeper knowledge about collaborating in these new settings. Third, Emons is operating in the logistics of the glass and retail industry. In the glass industry only a small number of companies are involved, which almost all of them are small to big customers of Emons. Which makes this one case at least quite complete for the logistic of glass. These customers will be used for the interview design. The retail industry is a big industry with a lot of companies involved. Having a focus group with some of these companies will help to create more understanding on the topic and raise the generalizability of the research. Sticking to one case does have a disadvantage on the generalizability of the results of this research, as they can occur just in these specific settings.

3.3.1 SELECTION METHODS

Second, the selection method should be selected. To select the sample a combination of purposeful sampling and quota sampling. As mentioned before, this research tends to look for a specific unit of analysis. Bearing in mind that not every partner is willing to cooperate in this research, every specific unit of analysis should be used when possible. Due to the fact that a partner of a SME in the logistic industry can have different purposes (customer, supplier, etc.), this research tends to focus on customers only (forward vertical collaboration). Therefore, making it purposeful. Subcategories can for example be formed between customers and non-customers of Emons. Emons provided a list of ten potential persons that work at a company that serves currently as a customer. Also, Emons gave two companies that are currently not a customer. All these companies are companies within the glass industry and will be selected for the interviews. Emons also provided a list of 20 companies within the retail industry that are invited for the focus group.

Securing the correct sample size is hard to define. “In qualitative studies, sampling typically continues until information redundancy or saturation occurs. This is the point at which no new information is emerging in the data.” (Maxwell, 2012). Therefore, it is important that collection and analysis of the data are occurring simultaneously. For this research, a sample size of at least five units is desirable, because it strongly depends on the willingness of the partners of Emons to cooperate. Moreover, the most important task is that saturation occurs.

3.3.2 ACTUAL RESPONDENTS

For the interviews, five top managers in the supply chain of the glass industry were willing to cooperate. Table 4 illustrates the characteristics of the respondents.

Function	Gender	Located	Contact-type	Length	Date
Logistic manager	Female	Germany	Face-to-face	58:35	18-04-2019
Transport manager	Female	Germany	Face-to-face	45:25	18-04-2019
Regional supply chain manager	Male	Netherlands	Face-to-face	60:45	24-04-2019
Logistic manager	Male	England	Face-to-face	50:32	08-05-2019
Central logistic manager	Male	Netherlands	Face-to-face	53:55	09-05-2019

Table 4: Interview respondents

For the focus group, four top managers within the supply chain of the retail industry attended. Table 5 illustrates the characteristics of the attendees.

Function	Gender	Located	Contact-type	Length	Date
Head of transport	Male	Netherlands	Face-to-face	≈45:00	16-05-2019
Logistics manager	Male	Netherlands	Face-to-face	≈45:00	16-05-2019
Transport manager	Male	Netherlands	Face-to-face	≈45:00	16-05-2019
Regional transportation manager	Male	Netherlands	Face-to-face	≈45:00	16-05-2019

Table 5: Focus group attendees

3.4 Collection procedures

To ensure that that the data is collected properly, collection procedures are set up in advance. Several recruitment strategies have been thought out based on the works of Morse, Barrett, Mayan, Olson & Spiers (2002); Marschall (1996) and Strauss & Corbin (1990) to make sure that enough data will be gathered and data saturation will be established.

- The customers will be approached personally with a personal salutation.
- There will be mentioned that the research guarantees confidentiality (No names or company names)
- For the non-responders, a reminder will be sent.
- The content of the questionnaire and questions of the interviews will be thought through first, by testing them on colleagues of Emons before sending them to customers.

The interview invitation can be found in Appendix 3: Interview invite. The data of the interviews are collected preferable face-to-face. This will raise the chances of getting deeper knowledge on the attitude and motivation towards questions. The interviews were held in different countries (Germany, the Netherlands and England) and together with an employee of Emons, William Emons. When this is not possible due to distance or time issues, skype is also acceptable. In both scenarios the conversation is completely recorded. This assures that no word will be lost during the collection. The interviewees were to give permission beforehand. Also, the interviewees were to sign an informed consent form. This form can be found in Appendix 4: Informed consent form. three days before the interview, the interviewees were sent a general topic list. This was done due to the complexity, so that the interviewee could get familiar with the subjects.

Afterwards the record will be transcribed. To raise the reliability of the research, the transcription of the interview will be sent to the interviewee for feedback and validation. Here the interviewee can add some words, change things that have not been understood well or approve was has been transcribed. The interviewees participated on a voluntary basis and were not compensated for it. All transcripts have been translated to English and cleaned from filler words or incomplete sentences for improved readability. Identifying information was removed to ensure confidentiality. All transcripts of the interviews van be found in Appendix 5: Interview transcripts.

The focus group was held during a customer day within the company. 45 minutes were scheduled to do a focus group with the attendees. The attendees were to give permission beforehand. Also, they were to sign an informed consent form. This form can be found in Appendix 4: Informed consent form. This focus group could not be recorded due to permission issues; therefore, the attendees were to write key notes on an A3 paper in a workshop form. This collective paper can be found in Appendix 6: Focus group notes. The attendees participated on a voluntary basis but were compensated afterwards with a general present from the company Emons and a comprehensive lunch.

3.5 Analysis methods

The data that is collected should also be analysed correctly. The data from the in-depth interviews and focus group will be analysed by coding. This coding will be done based on an iterative process, as mentioned before. The coding starts by open coding. When categories can be made up by open coding,

axial coding and selective coding can take place. Here a story is being established based on the categories. Additionally, the date, length, language and type of interview was attributed to the transcripts. In the next step, basic themes were identified and matched back to the original questions in the interview guideline via holistic coding to understand the structure of the transcripts and general attitudes of the participants in preparation for more detailed coding methods (Saldana, 2013). In case of the focus group, the written issues were already divided into categories. In For coding the data, this research uses the software program NVIVO. After coding and establishing categories from the interviews, the data can be further analysed by comparing them, establishing connections and discover patterns. (Morse et al., 2002). For every subject of the interview/focus group, a different analysis method is used.

The first subject, collaborative experience will be analysed by using the maturity industry 4.0 model of Ganzarain et al. (2016). The second subject, drivers of collaboration will be analysed by the list described by Palmer et al. (2012) in combination with the model of Müller et al. (2018). The third subject, barriers, will be analysed by the summarized literature described in the theoretical framework. At last, the fourth subject, partner preferences will be analysed by the summarized literature also described in the theoretical framework.

3.6 Reliability and validity

The quality of the research can be assessed by considering the reliability and validity. Reliability describes the degree to which a scientific tool provides consistent and stable results independent of the timing or researcher (Babbie, 2012). In this notion, it is important that data is used and analysed correctly. On the other hand, validity evaluates the accuracy of the items in measuring what they are supposed to measure (Babbie, 2012). This includes using different concepts for explanation and selecting the best research methodology.

3.6.1 RELIABILITY

To ensure the reliability of the research, multiple measures have been taken. First of all, the research process is documented in detail. For ensuring the reliability this is necessary. (Miles & Huberman, 1994). Of course, different possibilities arise when meeting the research problem at first hand. The influence of the company Emons that initiated the research does have an influence on the research direction in some way. For example, the choice to only address collaboration in vertical forward collaboration and the appointed list of potential participators handed by Emons. Despite these choices the interview format is based on extensive literature research on the attended research problem. The translated transcripts are provided to ensure that readers can comprehend interpretations. Furthermore, participants had different positions and worked for different companies in the same industry, which ensured that qualitative data was triangulated across different individuals. Also, the research ensures respondent validation. The participants had the possibility to comment on the interview transcript and whether the final themes and concepts created adequately reflect the phenomena being investigated. At last the investigator acknowledges personal biases that may have influenced findings. This will be discussed further in the discussion section in chapter 5.

3.6.2 VALIDITY

There are several types of validity that need to be considered in this research. The three most important ones are discussed below (Verhoeven, 2011). First of all, the internal validity. Several situations that could endanger the internal validity of the results are listed below (Verhoeven, 2011).

- Selection of research subjects. Focusing on only forward vertical collaboration has an influence on the validity of this research, because it does not measure all facets of the construct. This does however, open doors for future research settings.
- Not only interviewing the same type of executives. Therefore, different types of executives (Transport manager, logistic manager, fleet managers) will be interviewed and the executives also need to operate in different sectors and companies.
- Instrumentation. During the research, if the results are measured in a different way, different results could be observed. For this reason, the results are only measured by methodical. Though, there are different results that require different methods (interviews and focus group), but each result will be measured with the only one method that is fitting. The interviews and focus group are tested to check the reliability and make additions when necessary.

Second the construct validity. Or in this case: is the test exploring what it wants to explore. As discussed in the theoretical framework section, the realisation of the research framework was a well-considered decision. Exploring the collaborative environment as a way to explore the field of collaboration in industry 4.0 context seems the best choice to measure what it needs to measure.

At last, the external validity. The sample has got to have several characteristics that correspond with the population. Considering this is a single case study, whereas the research sample was a convenience sample, it does certainly not represent the whole population. The customers of a logistic service provider are tested. These customers work either in the glass industry or the retail industry. The research might be generalizable to other manufacturing industries that are somehow connect with logistic service providers. This could be tested. On the other hand, horizontal collaborations or collaborations with suppliers from a logistic service provider point of view will probably be a whole different research with other dimensions and reasoning. (Palmer et al., 2012).

3.7 Summary

This sub-section aims to summarize the previous mentioned methodology of the research. A qualitative multi-methods design is chosen to find deeper understanding and reasoning of different customers towards collaborations in industry 4.0 settings. Semi-structured qualitative interviews with five top management practitioners within the glass industry seek to provide individual insights on their company's insights towards the research topic. Furthermore, a focus group with four top management practitioners from different companies within the retail industry seeks to provide a collective insight on the industry's thoughts towards collaborations in industry 4.0 settings. The interviews and focus group discuss the four elements within the proposed research framework: experience, drivers, barriers and partner preferences. The operationalisation of these elements can be found in Appendix 1: Interview guide, where the elements are formed into questions. The data collection and analysis were carefully documented. At last, considerations of reliability and validity were also examined.

4 RESULTS

In this chapter, the results from the qualitative research will be presented. First, the individual findings of the qualitative interviews are discussed and end with a small summary table per interview. After these findings, the results of the qualitative focus group will be reviewed and also end with a small summary. At last, an overall result will be discussed where the different cases will be compared and where both qualitative methods will be compared by a cross case analysis.

4.1 Interviews

Interviews with various top managers in the supply chain of the glass industry were conducted to explore the field of collaboration in industry 4.0 settings.

4.1.1 RESPONDENT A

Collaborative experience

During the interview, collaborative experience was the first subject of discussion. When discussing the experience, the respondent made it clear that the experience on this area focussed on the production area, rather than the logistic area. This is focussed on digitalisation. Although it is a board topic within the company, the respondent made clear that they are still seeking for concretization towards the trend. Also, the respondent noted that the company wants to establish a base of digitalisation first before crossing company borders. The respondent made a difference between industry 4.0 internal and external. At last the interviewee concluded that the motivation is there and they're at the point of just wanting to try. Based on the motivation towards industry 4.0 but the little till no experience, this respondent can be categorized as preliminary stage planners according to Müller et al (2018). Looking at the model of Ganzarain et al. (2016) they can be mapped in the envision stage at step 2. They have a vision towards industry 4.0 but are still developing understanding towards industry 4.0 with specific capabilities and resources.

Drivers

When discussing the drivers for collaborating in industry 4.0 settings, the respondent explained that this is currently from an internal motivation rather than external pressure. Always looking for ways to make the business more efficient is important and one of the reasons they investigate industry 4.0. the respondent wants to foresee and prepare for the future and the coming 'digital generation'. Compared to the literature this can be seen as increased differentiation or service level. Furthermore, the respondent noted after asking that establishing the solid base to create valid and reliable data, the company does not need anyone. After this, they will look outside, which is the way the respondent believes in industry 4.0.

After showing the key drivers found in the literature by Palmer et al. (2012), the respondent went back to the future-proof scenario. Increasing the service level can provide this and is something the respondent agrees upon. Also demanding customers for the future are a main driver, as customers might expect more in the future and will look for others if the service is not high enough. With data protection rules and ISO, close attention is payed to all outgoing and incoming data, so that is a small driver too. Talking about the importance, the respondent prioritized demanding customers, service level and increased differentiation as main drivers considering the present and becoming more and more important in the future. Cost

reduction, increased competition and regulation are rather small drivers and will remain the same in the future. For sustainability and reducing CO2, the respondent does not see a link with industry 4.0.

Partner preferences

Considering the partner preferences, the respondent answered from a hypothetical point of view as there is no experience outside the company borders. Within this specific industry 4.0 context experience is not specifically what the respondent is looking for, because she believes that it would probably not be there. A start up would be an interesting choice according to her. Openness and willingness to try are very important preferences. When discussing this topic further, the respondent does not foresee a standard solution, because this requires huge customisation. Also, general market knowledge is important according to the respondent. Openness is in line with Barratt (2004) and willingness to grow can be seen as a compatible goal with the respondent's company. Compatible goals agree upon a lot of literature. (Brouthers et al., 1995; Barratt, 2004: Dalmolen et al., 2015; Naesens et al., 2009; Palmer et al., 2012). Preferring partners with market knowledge agrees upon Emden et al. (2006) that mention market knowledge when considering a collaboration partner.

After showing the key literature of partner preferences, the respondent called upon her own mentioned preferences and categorized them on the correct place. When elaborating more on market knowledge, the respondent gave an example of bringing in a third party as compensation for the lack of technological knowledge. This to underline the importance of market knowledge and the unimportance of technological knowledge. Afterwards other elements were discussed. Trust and information exchange were also considered important in this context as the respondent sees the relevance of sharing data as collaboration possibility in industry 4.0 context. Familiarity on the contrary is not as important, a start-up is also interesting according to the respondent. With that being said, the financial strength of a possible partner neither. Intra organisational support is very important as the respondent considers this an absolute no-go. The same goes for a business case, if there is no solid business case, the board will not approve a collaboration. At last the size of the company does not influence the choice of partner for the respondent.

The respondent prioritised trust, information exchange, openness, a solid business case, market knowledge and support as the main partner preferences. Also, for the future. All other elements can be seen as decent preferences except for familiarity, size and product characteristics. These elements are considered unimportant for selecting partners in the present and future.

Barriers

This question was also answered hypothetically as, according to her, the company wants to create a solid digital base internally first. So, not being ready internally is a barrier. When asked if the respondent's company is lacking speed towards industry 4.0, the respondent has a clear opinion. She feels like they are too late with digitalisation. The have enough possibilities to work with data, but the data is missing, meaning the missed out on a step. Masdefiol et al. (2016) described this as a too low level of automation.

The first mentioned barrier for not collaborating in industry 4.0 context are people according to the respondent. Getting everybody to understand the concept and how to work with it can take a lot of time and effort. Missing key people to help with this is a main barrier. Masdefiol et al. (2016) also mention

missing key people as a barrier for not collaborating in industry 4.0 context. Describing more barriers without a list from literature seems hard for the respondent. It seems she can't point out the problem. After showing the key arguments found in the literature, the respondent grabbed missing key people as a first argument as it agrees with her made argument. Too much financial effort could be a key barrier as we discussed a solid business case in the previous sector. Too much costs could be a no go from the board.

Lack of information, missing key people, bounded rationality and too low level of automation are current reasons for not taking steps within industry 4.0. Afterwards when this is 'established', the respondent expects lack of trust, too much financial effort and no solid business case as main barriers for not taking the step afterwards. The respondent expects that switching costs and lack of scalability will not form a barrier afterwards.

All this together leads to the following overview in Table 6:

Respondents A	Main findings	Other findings
Collaborative experience	Preliminary stage planner (little to no experience)	Only a user role
Drivers	Internal motivation and internal focus	Also service level and no link to CO2 and sustainability
Partner preferences	Trust, information exchange, openness, a solid business case, market knowledge and support	Solution not necessary
Barriers	Lack of information, missing key people, bounded rationality and too low level of automation	Lack of trust, too much financial effort and no solid business case later on

Table 6: Summary of analysis respondent A

4.1.2 RESPONDENT B

Collaborative experience

Considering the collaborative experience, the respondent indicated that from his opinion there was very little experience. In the warehouse department they are at the start of a pilot. How to work as efficient as possible. The respondent mention this as warehouse management based on data, to make sure that things go in a smart way and don't have to be done twice. They do this with a third party, which the respondent did not want to elaborate more on. When talking about third parties in other situations, he gave an example about the navigation app Waze in which they can optimise the traffic route. As a small example, the respondent wants to underline that data from outside of the company can be very useful when creating supply chain visibility. Furthermore, the respondent sees industry 4.0 as a fully automated warehouse where data can be used in an intelligent way to work easier. At last the respondent acknowledges that at the moment this comes from an internal motivation/interest rather than external pressure. While it is a board topic, it is still a relative far point in the future. The respondent thinks that in terms of innovation it is not the first in the line. Analysing these motivations and experience, the respondent can be categorised as a preliminary stage planner according to Müller et al (2018). Looking at the model of Ganzarain et al. (2016) he can be mapped in the envision stage at step 2. They have a vision towards industry 4.0 but are still developing understanding towards industry 4.0 with specific capabilities and resources.

Drivers

When discussing the drivers for collaborating in industry 4.0 settings, the respondent focussed on working more efficiently with the goals of cost reduction. A lot of data is currently gathered manually at the respondent's company. She thinks that collaborating based on data could help them with digitalising and making sure data is not collected twice. Cost reduction is also mentioned by Palmer et al. (2012) as a main driver for collaboration. The respondent could not think of other drivers.

After quickly analysing the shown literature, the respondent came back to cost reduction but also mentions service level. She thinks working with industry 4.0 would also improve their service, because having access to more information quicker could improve their contact with customers. Furthermore, sustainability and reducing CO2 could be established when working more efficiently. The respondent gave an example of having access to more information could make sure that the route is more efficient and empty kilometres could be reduced on the return. Demanding customers are in line with increasing the service level according to the respondent, which makes this also an important driver. At last, the responded noted that increased competition and regulation are drivers but not with the same importance as the others.

Partner preferences

The respondent marked that she has been thinking a lot about this question before the interview and thinks this is a hard question. The first point she makes is about trust. The possible partner needs to be aware of the fact that sensible information will be shared. She gives an example of a supplier like Emons having these forms of collaborations with several glass manufacturers. What will happen with all the data? Therefore, trust in the partner is very important. Again, this agrees upon literature. (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004). Second, the possible partner should have the ability to think ahead. With all the data the possible partner could deliver solutions possibilities in advance. To think ahead, market knowledge is required. (Emden et al., 2006).

Apart of culture, all the cultural elements can be seen as main preferences according to the respondent after reviewing the key literature. The respondent notes that a fundamental fit in culture is kind of the same as compatible goals when considering the strategical fit. Nevertheless, the respondent thinks that both are important preferences. She thinks if the partner wants to develop in another direction than their company with the same data, this would probably not work. Analysing the strategic elements, the respondent points out that financial strength is not important when considering a possible partner. However, a strong business case and intra-organisational support are. Especially the support, as with sharing data the respondent thinks that close contact between companies is a necessity. Furthermore, technological fit is important, the company need to be technical and digital ready to work with data. Although on the other hand, the technological knowledge does not necessarily need to be higher than their company as they could work their way around with a possible third party. Last, operational fit and for example size are not preferences when for selecting a possible partner.

Barriers

At last the barriers were discussed. Because the respondent says that at the moment the company want to digitalise first before crossing company borders, this could be seen as a first barrier. Masdefiol et al. (2016) described this as a too low level of automation. The respondent mentions the boards choice to focus on internal industry 4.0 innovations only could be a potential showstopper. As their company is still seeking their possibilities and resources on this particular subject this could might happen. Board making other decision can be seen as missing key people or no aligning business strategy found by Masdefiol et al. (2016). Also, people could be a barrier according to the respondent. Employees on the work floor should accept working this way or understand it. This could be a barrier.

After showing the barriers found by literature, the respondent linked her words to missing key people and possible no aligning business strategy. Also bounded rationality can be seen as a barrier compared to her words about operational people dealing with this trend she says. For her these are the main barriers. Furthermore, she mentions bad accessibility and bad quality of data as barriers and gives an example of a not perfectly working internal system. Although these barriers are there, the respondent did not think these were as important as the previous mentioned barriers. Technological knowledge could form a potential barrier according to her, because she thinks suggests that the best systems will not work if not matched well with their internal knowledge. At last financial issues are not barriers the respondent is thinking of, as a solid business case would be sufficient.

All this together leads to the following overview in Table 7:

Respondents B	Main findings	Other findings
Collaborative experience	Preliminary stage planner (little to no experience)	Only a user role
Drivers	Internal motivation and internal focus for cost reduction	Also service level (less priority) and no link to CO2 and sustainability
Partner preferences	Trust, market knowledge, fundamental fit and support	Financial strength is not important and technological level should be 'enough' not necessarily higher
Barriers	Too low level of automation, bounded rationality, missing key people and lack of information	Financial barriers not there if there is a solid business case

Table 7: Summary of analysis respondent B

4.1.3 RESPONDENT C

Collaborative experience

According to the respondent, there was very little till no experience when it comes to industry 4.0 and collaboration. Some work groups where established to explore possibilities the company has when considering industry 4.0. The respondent did however make a distinction on internal focus and external focus, whereas the internal part should be 'finished' before looking outside the company's borders. Considering the internal part, the respondent mostly talked about forms of digitalization. When discussing industry 4.0 in more depth, the respondent sees a future where in the end they can gather data through the whole supply chain and can connect this. With this she thinks they can improve the service of the whole network they operate in. Gathering ideas on what possible solutions they have, without knowing if this is practically possible is their current status. Considering the model of Müller et al. (2018) they can be

seen as preliminary stage planners, as their motivation is there but experience lacks. In the model of Ganzarain et al. (2016) they would be at the envision stage step 2, as they are still developing understanding towards industry 4.0 regarding specific capabilities and resources.

Drivers

The second topic of discussion was about the drivers. The respondent urges for a clear business case. With this he means linking the technology to the people. Based on this clear business case, the respondent acknowledges that the main driver behind this is working more efficiently. By working more efficiently costs can be spared and service level will increase, which agrees upon lots of literature. Seeing this as main drivers for collaborating is in line with Palmer et al. (2012). After confronting the respondent with the theory, he mentioned directly the link with cost reduction, service level, but also demanding customers. They notice that in the present time customers want to know more and more about the time the product arrives. Collaborating more on data to know more about these specific elements would help with that tremendously. Furthermore, increased competition is less of deal, as the respondent thinks that in their business it's not really about what they make but how they offer it. The respondent does not link reduced CO2 and sustainability with industry 4.0. By prioritizing the different drivers, it became apparent that cost reduction, demanding customers and service level are very important and can be seen as main drivers for the respondent. Increased differentiation and competition are drivers but with a less priority. At last increased regulation, reduce CO2 and sustainability are no drivers from the respondent point of view.

Partner preferences

The first preference the respondent mentions when asking about this topic is credibility. He would demand for prove in what the possible partner can do on this level. Market knowledge is therefore very important in combination with experience. Market knowledge and experience is in line with Emden et al. (2006) that takes market knowledge in consideration when selecting a partner. A strong business case is a necessity according to the respondent. Dalmolen (2015) and Barrat (2006) also mention business case as a criteria element. Also, trust is mentioned by the respondent. By working with data that can be possible interesting for competitors a supplier can work with, this can be marked as an important preference. Trust is a commonly agreed element in selecting a partner according to theory. (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004; Palmer et al., 2012; Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006). Openness to exchange data is a relative new element that is only mentioned by Barratt (2004), Naesens et al. (2008) and Palmer et al (2012).

When it comes to trust, the respondent elaborates more on this. He seems to see a difference between using public data and private data. Using private data is more sensible and is in ethical matters harder to underline what is right and what goes too far. This distinction between public and private data is also done by Dalmolen et al. (2015) as they also acknowledge the legal matters between these two categories. When talking about trust, the respondent wants to make sure that when data is exchanged it is still legal and ethical. Therefore, trust is needed. After showing the list of theory involving partner selection, the attention of the respondent reached to mutuality, a part of the just mentioned elements. Having the same long-term goals and wanting to achieve the same thing is for the respondent a main partner

preference. All the culture elements apart of familiarity are main partner preferences too. Furthermore, the respondent urges for a connection between technological ability and market knowledge as main partner preference. At last he admits that every element can be important and thinks it's hard to say what can be prioritised as not (so) important.

Barriers

Fear for the unknown. The respondent acknowledges that the company is not the first in line with innovation. As industry 4.0 is still relatively a broad trend there is some uncertainty about it definite forms. As long as this is not clear yet, there will be some form of anxiety. This fear can be seen as a personal barrier in the form of bounded rationality mentioned by Kazantsev et al. (2018). Although Kazantsev et al. (2018) focus on SME's, it is interesting that this also lives at a top manager from a bigger company. The respondent also mentions the missing of priority on this. Missing priority could be because there is no real pressure from extern parties as mentioned by Müller et al. (2018) and/or no clear business case mentioned by Masdefiol et al. (2016).

After showing barriers mentioned by key literature, the respondent connects with the previous arguments and points out bounded rationality, missing key people and no clear business case as main barriers for not collaborating on industry 4.0 settings yet. The respondent also discusses the accessibility, quality and usefulness of information from their internal system as a main barrier. According to him a lot of data is there, so availability is not a barrier. Getting access to all the however is an issue, as delivering all information in the same format (usefulness). The respondent also urges for quality over quantity with information, which lacks at the moment. All these barriers about information however are also drivers to improve according to the respondent. Furthermore money/costs are not a barrier for the respondent, if there is a solid business case. At last technological knowledge is a barrier as the respondent thinks they are somewhat behind on the latest software and functions in their systems.

All this together leads to the following overview in Table 8.

Respondents C	Main findings	Other findings
Collaborative experience	Preliminary stage planner (little to no experience)	Only a user role
Drivers	Internal motivation and internal focus for cost reduction but also feeling pressure from outside	Also service level and no link to CO2 and sustainability
Partner preferences	Market knowledge, experience, strong business case, trust and openness	Mutuality, all the culture elements and a connection between technological ability and market knowledge
Barriers	Bounded rationality, no real pressure from outside, no clear business case, technological knowledge	Accessibility, quality and usefulness of information and costs are not a barrier

Table 8: Summary of analysis respondent C

4.1.4 RESPONDENT D

Collaborative experience

The first subject was about collaborative experience in industry 4.0 settings. The respondent could tell that he has experience considering this topic. The company he works for is always looking for ways to improve their business with less resources and create a special customer experience. They use the platform Transporion to collaborate between different departments and with their logistic service providers. With this they work more centralized and work more efficiently. The respondent also elaborated more on the industry 4.0 topic and mentioned that for him industry 4.0 is not only about information sharing but also about improving communication. With this he means delivering data on time as a priority. Considering the difference between internal motivation and externally pressured, the respondent seems to see a combination between these two. Receiving feedback from customers or suppliers about information as external pressure on one hand and creating solutions people don't know about beforehand as internal motivation. Furthermore, the respondent sees a user as a provider role in industry 4.0. Considering the experience, the motivation to foresee a leading role as a company in industry 4.0 and seeing both a user as a provider role for industry 4.0, the respondent can be categorized as a full-scale adopter in the model of Müller et al. (2018). In the model of Ganzarain et al. (2016) the respondent can be categorized in the enact stage step 2, as the respondent did not make a difference about prioritising different portfolio's within industry 4.0.

Drivers

Considering the drivers for collaboration the respondent focusses directly on creating an amazing customer experience, by improving their customer service. Ultimately, they want to do this with as less as possible resources, to control the overhead. Analysing these two drivers, they can be seen as increasing service level and reducing costs, which is in line with the found drivers in the paper of Palmer et al. (2012). After elaborating more on the drivers, the respondent prioritized service level as more important than costs. After confronting the respondent with the list of drivers from Palmer et al. (2012), the respondent compared his answers with the theory. Apart of the mentioned topics, service level and cost reduction (can be seen as main drivers), the respondent talked about increased differentiation and competition. According to him you always want to be ahead of competition by differencing. Although competition does not force them to change, this is more an internal motivator which makes it not a driver. The respondent does not see regulation as a driver, as they have a third party that takes care of this topic. At last, reducing CO2 and sustainability is very important to them too. Reloading transport is a perfect example of this according to the respondent. Less dry kilometres lead to reduced CO2. So, CO2 and sustainability can be seen as important drivers.

Partner preferences

The third topic of discussion was about partner preferences. The respondent raised the importance of a long-term fit. The company must have the same goals as the respondent has. For example about implementing, the respondent urges for a company that looks further than just implementing and focuses on the long-term relationship. This can be seen as mutuality/ fundamental fit according to (Brouthers et al., 1995; Bronder et al., 1992; Barratt, 2004; Emden et al., 2006; Naesens et al., 2008; Palmer et al.,

2012). The respondent also explained that a company should be flexible and experienced in knowing what to do and giving the right amount of service. Flexibility and experience in the topic can be seen as a technological fit as flexibility depends on having the proper amount of technology (Dalmolen et al., 2015). While experience in the field of industry 4.0 is mentioned by Palmer et al. (2012). Having experience depends on several elements. Service level is part of operational fit and is mentioned in theory by Naesens et al. (2009).

After discussing the key elements mentioned in theory, the respondent discusses the word vision and compares this to fundamental fit and compatible goals. This can be seen as a main preference according to him. Second the respondent focusses on trust and sees this also a main preference. Especially considering the exchange of data. Which also raises the importance of openness and information exchange. The respondent also demands for companies that do have the technological ability and experience in this topic. A concrete concept of proof is what he is looking for, which raises the importance of a business case. Market knowledge and technological ability is therefore a necessity according to him. After discussing this, the respondent acknowledges that this is because they already have experience in this topic. Furthermore, he suggests that financial strength and size of the company are also preferences. This, however, depends on the scalability of the possible collaboration.

Barriers

Discussing the barriers that come forward while collaborating in industry 4.0 settings, the respondent mentions two barriers. One of these barriers is people, as he says that every specific region demands its own specific needs. This can also be seen as a technological barrier as the solution needs to be adjusted to these settings which looks like a technological impediment. However, this is a barrier while implementing something rather than a showstopper for not engaging with industry 4.0, which lowers the importance of this barrier. The respondent does imply that the implementation is slowed down since the start but does not think that is a problem. He does not want to rush as every step helps them to improve their customer service. From their strategy point of view, the respondent thinks they are pretty on time.

Getting people on board was a barrier they experienced in the last two years according to the respondent after discussing the theory. As more and more systems where connected through the different workstreams, people had their complaints. This is still happening but not a real showstopper as people will get on board eventually. So, based on theory only bounded rationality can be considered as a barrier for the respondent in the current situation. At last the respondent elaborated more on technological barriers. He thinks this is very complex as “You don’t know what you don’t know”. Considering the future this is a main barrier according to him as he raises the importance of keeping looking outside of you own company to look for trends and improvements.

All this together leads to the following overview in Table 9.

Respondents D	Main findings	Other findings
Collaborative experience	full-scale adopter (experienced and ambition to be leader in this innovation) platform solution with their suppliers	User and provider role
Drivers	Internal motivation and external pressure all for creating a great customer experience also link to CO2 and sustainability	Also cost reduction but never over customer service
Partner preferences	Long-term fit, technological fit, experience and service level Experience and size are important due to scale	Trust, openness, information exchange, business case, market knowledge and technological ability
Barriers	technological barrier for adjusting technology over different areas bounded rationality to get all people on board	-

Table 9: Summary of analysis respondent D

4.1.5 RESPONDENT E

Collaborative experience

As the respondent started, he mentions that he was not really known with the topic before getting informed about the subject of the interview. After looking into it before the interview, the respondent recognizes some facets of industry 4.0 in their own activities. He mentions small E-CMR projects as ways to share data with customers. With this they are digitalising among other things their shipping documents to inform their customers with clear information. Although this is still a way to improve their service level towards their customers rather than collaborating within industry 4.0 settings, as they are more off digitalising their business. Digitalisation is more of a step before industry 4.0. (Ganzarain et al., 2016). After discussing the topic of industry 4.0 more, the respondent acknowledges that his company wants to focus on the internal part first before looking outside. He does however see the trend rising with rapid pace and notices that companies are digitalising more and more. The respondent rates their 'internal' part by digitalising by 5/6 on 10 and acknowledges that there are plenty of possibilities that they have not discovered yet.

Although some customers of the respondent demand for more and more information there is also an internal motivation. Considering the customer's demand, the respondent things this is also quite odd as he thinks the glass industry is very conservative. He notices also a lot of customers still working with fax, especially in Germany. The respondent however does think it is a true need the customers that are not as conservative have, as they are also digitalising and need more information to take further steps. Again, considering the internal motivation, the little experience (especially in digitalization), the respondent can be categorized as a preliminary stage planner in the model of Müller et al. (2018). In the model of Ganzarain et al. (2016) he finds himself in the envision stage at step 2. They have a vision towards industry 4.0 but are still developing understanding towards industry 4.0 with specific capabilities and resources.

Drivers

The second topic of discussion considered the drivers for collaboration and industry 4.0. The respondent used the digitalisation as example and mentions all the paperwork and time wasting as main driver. This can be seen as cost reduction. Later, he also foresees the demanding customers as a driver and sees a link with improving their customer service as driver. So first-hand costs but also service level.

When confronting the respondent with the main drivers found in the literature, he again mentions cost reduction and service level. He does however switches now in prioritisation and places service level improvement as just as important as cost reduction. Furthermore, he mentions regulation problems in Germany. This could more be seen as a barrier rather than a driver as it does the opposite for them. So, this is not a driver. Also, the respondent does not match industry 4.0 and collaboration with reducing CO2 and sustainability. However, he thinks that this will be different in the future. At last, increased competition and differentiation is a small driver as he mentions competition being ahead of him.

Partner preferences

When discussing the possible partner preferences, the respondent has when considering collaboration in industry 4.0 settings, he comes up with the term wideness. With this he means the richness of the solution the possible partner has to offer. According to the respondent it needs to fit in their market and with their internal systems. With this being said, his mentioned preferences match with some elements found by literature. For example, the wideness of the product reaches to operational fit as product characteristics found by Naesens et al. (2009). Also, the fit to the market agrees upon having market knowledge found by Emden et al. (2006). Having a product or solution that already works, requires also a solid business case found by Barratt (2004) and Dalmolen et al. (2015). Matching the product with internal systems of the respondent requires the correct ICT integration, known as a partner selection criterion, mentioned by Naesens et al. (2009).

After discussing the main selection criteria found by literature the attention to trust became also apparent. While working with data, openness and information exchange were also important topics. Furthermore, the respondent emphasises the importance of having a solid business case as prove for having a working solution. When discussing the topic of size, the respondent lowered its importance as this depends on the scale of the project.

Barriers

The respondent thinks that his company is taking quite some steps to improve their digitalisation process. After some bad financial years there is room for improvement now, according to him. Although there is financial room and this does not necessarily be a barrier anymore, the acceptance of people to change is. The respondent mentions the conservative attitude of people as a main barrier. He mentions the media play an important role in this, as data breaches or in the news all the time and scares people to share data in some way. The respondent notices that Germany is the most conservative with this. The respondent also mentions a form of distance towards the bigger companies in the industry as main reason to keep them alive as a SME. The topic of data sharing and it legal and ethical limits came to discussion. This can also be seen as bounded rationality and lack of trust found by Kaipia & Hartiala (2006) and Kazantsev et al.

(2018). After discussing the barriers found by literature the conversation focused on the people aspect again. Trust and bounded rationality are the main barriers. As the company's experience on this topic is very low, I would also suggest that the low level of automation is a main barrier. The respondent mentions the difference between internal and external focus on industry 4.0 and internal being a priority before looking external. As they are still focussing on the internal part with as mentioned digitalisation projects, the low level of automation/digitalisation is a barrier for not collaborating on industry 4.0 settings yet. As this can be seen the external part of industry 4.0.

All this together leads to the following overview in Table 10.

Respondents E	Main findings	Other findings
Collaborative experience	Preliminary stage planner (little to no experience) Seeing digitization solutions like industry 4.0	User but also in the future a provider role
Drivers	Internal motivation and external pressure cost reduction, demanding customers and service level	No link to sustainability and CO2
Partner preferences	Product characteristics, Market knowledge, solid business case and ICT integration	Trust, openness and information exchange Size depending on scale of the project
Barriers	Bounded rationality, lack of trust and too low level of automation	Mention trust issues with bigger companies Internal before external focus

Table 10: Summary of analysis respondent E

4.2 Focus group

A focus group was held with various top managers in the supply chain of the retail industry, to explore the field of collaboration in industry 4.0 settings.

Collaborative experience

The first topic of discussion during the focus group was about the experience the attendees had with industry 4.0 and collaborations. The group was asked about their familiarity with the subject first, here it became apparent that all of the four attendees heard of the concept but could not really encompass it. For them it is a relatively new trend. After explaining a little of industry 4.0 and collaborations in these specific settings, the attendees explained that they are not that far as they are still dealing with digitalisation issues within their companies. All the respondents noted this as a problem and none of the attendees could give clear examples of experience within this topic. They see a difference between internal digitalisation and crossing company borders with sharing information collaborate in these settings. Three of the four attendees considered only a user role within industry 4.0 while only one of the four attendees discussed a provider role when collaborating with their logistic providers. After this topic came to debate, the other attendees could imagine this role of a provider too. During this debate, the planning of logistics became apparent. Questions were made about the annual forecasting they are currently using for their logistic plan. Adjusting and collaborating on this planning seem to be a solution for the future to create supply chain visibility between the retail industry and logistic providers. Considering the model of Müller et al. (2018) they can be seen as preliminary stage planners, as their

motivation is there but experience lacks. In the model of Ganzarain et al. (2016) they would be at the envision stage step 2, as they are still developing understanding towards industry 4.0 regarding specific capabilities and resources.

Drivers

During the discussion on the drivers for collaborating in these specific settings, it became apparent that all the attendees see cost reduction as their main driver. They discussed immediately the advantages of working more efficiently and reducing costs with it. They did not seem to be interested in increasing their service level. A second driver for them is reducing CO2 to increase the sustainability. They were discussing the certificate of becoming 'lean and green' and foresee huge options when collaborating more to reduce the dry kilometres on the return drive. The different attendees even discussed the possibilities to share return loads with the help of logistic providers. Furthermore, they described that being a 'green' company is very important in their business. Increased regulation did not seem to be a driver. Also increased competition and differentiation did not seem to be a driver as the company focusses more on the front end in the retail stores where they connect with their customers.

Barriers

At last the barriers were discussed. As a first reaction all the attendees focussed on their IT having major disadvantages. Three out of the four attendees mentioned different projects in IT they are implementing. For example, a TMS system. Also, an attendee mentioned still using Lotus IBS, which is in his eyes very conservative as this has been in use since the start of these sort of systems. Having an IT disadvantage agrees upon the paper of Masdefiol et al. (2016) that describe this as a too low level of automation. Furthermore, the attendees discussed people being a barrier. Changing people within the company to do things completely different felt like a major challenge. The attendees once again spoke about using the annual forecasting techniques for their transport plan and doing things 'like they are used to'. Making transport plans from data through the whole supply chain could cause people to oppose it. This argument is in line with the paper of Masdefiol et al. (2016) again, that mention bounded rationality to be a barrier. When discussing the key point found in literature, the attendees focussed on IT again and mentioned this being the major issue here. Financials are not seen as a barrier.

All this together leads to the following overview in Table 11.

Focus group	Main findings	Other findings
Collaborative experience	Preliminary stage planners (little to no experience) Relatively new trend	User role only Difference between internal and external industry 4.0
Drivers	Internal motivation and internal focus for cost reduction Link to sustainability and CO2 and came with solution for	Not for increasing service level Potential to share return loads between different customers
Barriers	Too low level of automation, bounded rationality	Financials are not considered as a barrier

Table 11: Summary of analysis focus group

4.3 Overall – Cross case

4.3.1 COLLABORATIVE EXPERIENCE

By analysing the collaborative experience in industry 4.0 settings, it became apparent that there is little to no experience on this topic except for respondent D in the interviews. Four respondents (A, B, C & E) working for different companies within the glass industry and all the attendees of the focus group working in the retail industry, did find motivation towards the topic but are still developing understanding towards it regarding specific capabilities and resources. Considering the stage model of Müller et al. (2018), all these companies can be categorized as preliminary stage planners. The development of the understanding towards industry 4.0 can be illustrated by respondent A:

"We just want to see and try, with the data we have, what we can do with it, how we can use it, to make the business more efficient."

All of the respondents recognized the importance of connecting with possible partners in the supply chain to eventually make industry 4.0 work, which agrees upon the works of Barreto et al. (2017) and Schumacher et al. (2016). However, the respondents with little to no experience (A, B, C & E) all made a distinction between an internal focus and external focus when it comes to industry 4.0. This distinction is also made by the attendees in the focus group. In their opinion the internal part should be 'fulfilled' before seeking possibilities outside company borders. With the internal part they seem to implicate the digitalisation of their processes within the company. Respondent A illustrates this implication: "Before we can look into industry 4.0, we want to establish a solid base of digitalisation inside the company and with our data." This can suggest that within the glass and retail industry, a lot of companies (four of five respondents and all four attendees) are not yet 'ready' to achieve the idea of a fully integrated industry (industry 4.0), because they are still dealing with the digitalisation of their processes. Masdefiol et al. (2016) already discovered this phenomenon and mention the level of automation as one of three concepts will determine if the concept of industry 4.0 is feasible for a company.

It could also suggest that a lot of companies within the glass and retail industry have a common misunderstanding of industry 4.0 in the context of possibilities. Especially Müller et al. (2018) mentions this current unpreparedness for implementing as these companies are still looking at how it will affect their business model. Respondent D displays an industry 4.0 like collaboration platform with their logistic service providers while his company is still going through several steps of digitalisation. Which shows that such solutions outside company borders are possible without digitalising completely and confirming this misunderstanding the other respondents have. The solution that respondent D displayed (Transporion) is a digital platform where logistic providers need to connect their actual logistic data with. With this data they tend to achieve real time information for their customers. Also, they formed a tender solution within this platform where logistic service providers can bid on several possible logistic loadings. An interesting solution which can be seen as an industry 4.0 solution in collaborative settings. Respondent D also discussed the attitude of the company wanting to be a leading firm when it comes to new technology. As respondent D was the only one that considered a user role as a provider role within industry 4.0 for them, they can be categorized as full-scale adopters of industry 4.0 according to Müller et al. (2018).

4.3.2 DRIVERS FOR COLLABORATION

First of all, the analysis focussed on being internally motivated and/or externally pressured towards industry 4.0 and collaboration. While all respondents felt internally motivated towards collaborating in industry 4.0 settings, only respondents D and E felt the external pressure too. In the retail industry none of the attendees felt external pressure towards it. Compared to the findings of Müller et al. (2018) this goes in hand with the maturity within industry 4.0, especially focussing on seeing themselves as not only a user but also a provider of industry 4.0. As respondent D is in fact a company that is more mature is the topic, this outcome can be seen as a confirmation for the research of Müller et al. (2018). However respondent E is not mature based on the previous findings, which might suggest that the respondent is already further in developing an understanding towards industry 4.0, but the capabilities his company has is holding him. The reason that the attendees from the retail industry do not feel external pressure is might because they work in a b-to-c market and their customers are not depending directly on logistics compared to the glass industry. However, the retail industry is working with logistic service providers and suppliers whereas they could have felt pressure from.

The main drivers for collaboration and industry 4.0 are to increase service level and to reduce costs. All respondents mentioned these two topics directly or indirectly. However, most respondents (A, B, C & E) and all attendees of the focus group seem to prioritize cost reduction above increasing service level. This agrees upon the findings of Palmer et al. (2016) where cost reduction is the most prioritized driver, although this paper focusses on collaborations in general (not industry 4.0 specific). The reason for this prioritization could also be found in the maturity of the respondents with industry 4.0. As again all the respondent that seem to have less experience within the industry 4.0 topic, tend to focus on cost reduction. Respondent D prioritizes the service level above cost reduction and illustrates this as following: “In my opinion there is no need to reduce costs when service level goes down too. Service level always must go up.”

While increasing service level seems like an external driver, cost reduction is an internal motivator. This agrees upon the previous findings where the distinction of internally motivators and externally pressured was made by the same respondents. Furthermore, other drivers came to discussion after confronting the respondents with the theory. Increased differentiation and competition where subjects that could be a driver for most of the respondents (A, C, D & E). Especially respondent E suggested that some bigger companies would be ahead of him, which was challenging to him. Increased regulation did not seem to be a driver in these specific conditions, as none of the respondents felt it to be a driver. At last reducing CO2 and sustainability was a topic of discussion. Almost all of the respondent (A, B, C & E) did not see a connection between these topics being a driver for industry 4.0 in collaborative settings. Again, this might suggest that a lot of companies within the glass industry have a common misunderstanding of industry 4.0 in the context of possibilities, which agrees upon previous findings in the collaborative experience section and with the findings of Müller et al. (2018). This suggestion is made because respondent D did see reducing CO2 and sustainability as important drivers and gave an example of a collaboration project, they were starting to reduce dry kilometres by reloading transport with cargo from other companies within the network.

This focus within industry 4.0 agrees upon the paper of Vasconcelos et al. (2014) that suggests solutions like 'information hubs' to create visibility in the supply chain and open doors for collaboration. Again, the maturity of respondent D could be the reason for a more developed understanding towards industry 4.0. All the attendees from the focus group however did see reducing CO2 and sustainability as a main driver. However, according to the attendees they feel a lot of pressure from stakeholders to improve their image to 'green and lean'. This might also be the reason for this discovery.

4.3.3 PARTNER PREFERENCES

By analysing the partner preferences, the first thing that became apparent is that again there is a difference between the respondent that has a higher level of maturity compared to the respondents that have a lower maturity considering this topic. The respondent with the high maturity (D) seems to prefer a partner with more size, creditability and scalable technology. This might be because the respondent that is more mature and has already a solution in own hands. Having an own solution lowers the chances of being impressed by a solution that is not yet ready enough. Unlike this difference in preferences between the respondents, almost all other preferences can be confirmed by them. Trust is a major preference, especially with sharing data between companies. This raises the importance of openness and information exchange of possible partners, mentioned by Barratt (2004) and Naesens et al. (2008). Long term fit/ compatible goals seem to be a main preference too, as all respondents mention this preference and importance of it. The size of the company seems to play a role depending on the scalability of the project. In small projects, size does not play a role. When the scope of a project reaches beyond country borders for example, companies prefer a partner with more size and higher creditability. In the theory, only Palmer et al. (2012) described size being a partner evaluation element.

Furthermore, it is interesting that respondent A and B also opened possibilities for possible partners with no experience in the solution, but solely with market knowledge. Respondent A describes this with the following sentence: "We are at the moment at the point of: we just want to try and see. Try together what possibilities and options would arise." Market knowledge is mentioned as a partner selection criterion by Emden et al. (2006). The possibility of third parties assisting with the necessary technology is therefore an option, according to respondent A. Also, service level of a possible partner seems important. Three of the five respondents described service level as necessary, when considering solutions that affect both internal systems of the collaborators agreeing upon the theory of Naesens (2009). When confronting the respondents with the theory, it also became apparent that they could find themselves in actually all of the elements. Especially respondent C acknowledges this: "Actually, al points on this list are interesting. When you see it, you think yes, it is logical that these points are on the list." The previous mentioned elements, however, seem to have higher priority than the others according to the respondents. At last, the legal aspect also plays a role when considering possible partners. Three of the five respondents discussed the lack of definition in legal aspect when it comes to sharing data. A possible partner, for example a logistic service provider, already having such a collaboration with a competitor could lead to ethical issues. Sure, this is also a trust issue, but this could also occur by accident. As the logistic provider can become a source of information, they can give indirect access to competitors by using information in a smart way. As none of the key papers in the theory mention rather not having a collaboration with a competitor as a partner preference, this might be an interesting addition to the existing theory.

4.3.4 BARRIERS FOR COLLABORATION

At last, the barriers for collaboration were analysed. As mentioned before in the collaborative experience analysis, four of the five respondents and all of the four attendees in the focus group mentioned a lack of digitalisation. This can be analysed as a too low level of automation mentioned in theory by Masdefiol et al. (2016). When analysing on this barrier further, it became apparent that this works his way through to lack of information. Especially accessibility, quality and usefulness of information are mentioned by for example respondent C: “Availability, no. There is enough. But accessibility, quality or usefulness are point that really can be better.” That a lot of barriers work their way through other barriers became obvious when analysing further. Technological knowledge is for example mentioned as reason for bad accessibility, quality and usefulness by respondent B: “The best systems will not work if not matched well with their internal knowledge.” In the retail industry the first thing that came up was the lack of IT which was a constant subject of discussion. As respondent D is the only one that does not mention internal digitalisation as a barrier (direct or indirect), the assumption that there is a difference between respondent D and the rest of the units of analysis on maturity in industry 4.0 and further analysis is once again confirmed. The barrier bounded rationality, however, is mentioned by every respondent and attendee directly or indirectly. Respondent D acknowledges this: “Again, getting people on board is something that will be a barrier when implementing ideas based on industry 4.0.” The bounded rationality in this argument is underlined by respondent E: “In the media you hear a lot about data breaches, so that’s what scares people.” The anxiety to change and work with data across company borders seems a major shift in change of mindset for the respondents and attendees of the workshop. Kazantsev et al. (2018) discusses this as one of the four reasons that prevent the uptake of industry 4.0, which can be confirmed by this analysis.

The way this argument could be eliminated is by having a solid business case. As a solid business case is also mentioned in the previous analysis in partner preferences, almost all respondents (A, B, C & E) mention not having a solid business case also as a barrier. As long there is no solid business there is no reason to take action or change things, according to Respondent C: “As long as there is no clear business case it won’t be of a high priority, also because it is kind of the unknown.” Schumacher et al. (2016) mention the uncertainty on the impact of industry 4.0 on the business model as barrier, which agrees upon the lack of a solid business case. What is also mentioned as a partner preference and barrier in the same time, is trust. Respondents A, B and D mention trust to be a preference as barrier, because of the issues concerning data sharing and the unknown ethical borders of it. Trust issues are also one of the four mentioned barriers found by Kazantsev et al. (2018).

Furthermore, during the discussion in the focus group between the attendees it became apparent that their annual forecasting controls their logistics. This, however, seems only a barrier in the retail industry. This can be seen as no aligning business strategy, mentioned in theory by Masdefiol et al. (2016). At last, financial issues seem not be a barrier. Only respondent A could imagine that in the future the financial effort could be a barrier. All respondents, on the other hand, mention a solid business case as a remedy for too high financial efforts.

5 DISCUSSION

This chapter focusses on the conclusions that can be drawn from the analysis this research has been executed. Second, this section describes the contributions of the research to the existing theory, connecting the extensive literature research beforehand with the conclusion afterwards. After this, practical contributions regarding this research will be given. At last, limitations and further research topics will be discussed and proposed.

5.1 Conclusions

This research focussed on the insights that come forward when exploring the field of industry 4.0 in collaborative settings. Extensive literature research indicated that the exploration of this specific field could be executed best by examining the collaborative environment. By examining the collaborative environment, the collaborative experience, drivers, partner preferences and barriers were subject of discussion. In the context of these four main elements the most important insights will be concluded, bearing in mind the three propositions that have been proposed before gathering data.

Digitalisation focus and common misunderstanding towards industry 4.0 in collaborative forms

During the analysis it became apparent that there is little to no experience when it comes to industry 4.0 in collaborative forms. In both retail as the glass industry only one of the respondents turned out to have experience and a high amount of maturity. Considering the maturity model of Müller et al. (2018), eight out of nine respondents can be categorized as preliminary stage planners. Two main reasons can be formed based on this finding. It can suggest that within the glass and retail industry, a lot of companies are not yet 'ready' to achieve the idea of a fully integrated industry (industry 4.0), because they are still dealing with the digitalisation of their processes. Masdefiol et al. (2016) already discovered the importance of digitalisation and mention the level of automation as one of three concepts that will determine if the concept of industry 4.0 is feasible for a company. Eight out of nine respondents mention this digitalisation process and underlined a difference between an internal and external focus when it comes to industry 4.0. This could suggest the second main reason that a lot of companies within the glass and retail industry have a common misunderstanding of industry 4.0 in the context of possibilities. Especially Müller et al. (2018) mentions this current unpreparedness for implementing, as these companies are still looking at how it will affect their business model. The only respondent that has a high maturity within the context also mentioned a digitalisation process but did not see this as a struggle to collaborate across company borders. In terms of possible solution areas, this respondent showed a platform-based solution whereas the respondent and his suppliers collaborate to improve data visibility though the supply chain with logistic information. Bearing in mind this solution, it also opens doors to other platform driven solutions. For example, the idea of load/garbage sharing to reduce empty miles came to discussion during the focus group.

Difference between internal and external motivation considering the main drivers (proposition 1)

The first proposition proposed that respondents that tend to have less experience in industry 4.0, have a more internal motivation towards the trend than feeling external pressured. When comparing the different interviews one best case stand out on the others based on their maturity within industry 4.0.

When analysing the motivations, it turned out that the respondents with less experience indeed tend to focus on internal motivation rather than external pressure. Several indirect arguments confirm this outcome. First of all, the respondents with less experience are seeing cost reduction (internal perspective) as main driver for collaborating in industry 4.0 settings, while for the respondent with more experience service level is considered as main driver. Although the other respondents with less experience also mention service level as main driver and confirms the findings of Palmer et al. (2012), this most of the times happened after confronting them with the key driver mentioned in theory. The respondent with more experience directly puts service level above costs, before showing the theory. Second, the one case that stood out foresaw a provider role next to a user role within the context of industry 4.0, where all of the other respondents could not comprehend this provider role. Considering the paper of Müller et al. (2018), this confirms the low maturity of the companies with internal focus. Third, the respondents with less experience and internal focus seem not to find a link between industry 4.0 and reducing CO2 while the respondent with more experience did. They all acknowledged the importance of sustainability but not in context of industry 4.0. This again, agrees upon Müller et al (2018) finding about the common misunderstanding companies with low experience have towards industry 4.0 and how it affects their current business model.

Low level of digitalisation, bounded rationality and the missing of a solid business case (proposition 2)

Different barriers came forward during the exploration of Industry 4.0 in collaborative settings. A lot of barriers work their way through other barriers, which is why some of them stand out compared to others. First of all, the low level of digitalisation mentioned by most of the respondents agrees upon the importance Masdefiol et al. (2016) lay on the level of automation determining the feasibility of industry 4.0. This expresses itself in different forms. For example, it became apparent that a lot of respondents lack necessary information. Especially the accessibility, quality and usefulness of information are mentioned as possible barriers. Also, technological knowledge is mentioned as a possible reason: “The best systems will not work if not matched well with their internal knowledge”, according to a respondent. For the respondents from the retail industry the lack of IT knowledge was a reiterate topic of discussion, confirming this barrier once again. As the respondent with more experience did not mention these IT related arguments as a key barrier, the proposition that respondents with little to no experience with Industry 4.0 tend to experience more barriers than companies with more experience, can be confirmed. Although the differences in barriers, both do experience a common barrier that is focussing more on the human area. This is expressed in the form of bounded rationality, also mentioned by Kazantsev et al. (2018) as one of the four reasons that prevent the uptake of industry 4.0. Although the respondent with more experience see this as a barrier that slow their implementation down rather than preventing them to implement, both level of respondents expresses same examples. The anxiety to change and work with data across company borders seems a major shift in change of mindset, where also trust seems to play a major role. At last, the lack of solid business case seems to be a main barrier. Where some respondents devote the missing of priority to the lack of a solid business case, others devote the uncertainty of the effects of industry 4.0 solutions to it. Financial effort, on the other hand, does not play a role if a solid business case will arise.

Trust issues, compatible goals and market knowledge (proposition 3)

By analysing the partner preferences, a difference between the more experienced respondent and the little experienced respondent became apparent again. The respondent with the high maturity seems to prefer a partner with more size, creditability and scalable technology. The reason for this seems that having a solution himself or being more mature, urges for a fitting partner in the same category. Being in this category seems to be needed of those elements. Although these differences stand out and extends the previous discussed propositions of differences among experienced and not respondents, a lot of elements were commonly shared among all the respondents. Trust especially focussed on openness and sharing information seem to be a major preference. An early study of Barrat (2004) already named these two elements as important when considering a possible partner. Long term fit/ compatible goals seem to be a main preference too, as all respondents mention this preference and importance of it. Furthermore, the size of the company only seems to play a role depending on the scalability of the project. Another interesting insight that came forward, is that respondents with less experience seem to open doors for partner with the same experience level. Meaning that actual experience is not a necessity. Market knowledge suffice in that context according to these respondents, alongside the other mentioned preferences. The interaction of a third party seems therefore a potential solution to overcome technical impediments and/or digitalisation issues. At last, the lack of definition towards legal and ethical barriers seems to raise trust issues for the respondents with little to no experience. Forming a collaboration with a competitor in the market can provide indirect access to other competitors by using information in a smart way. Therefore, no collaborative action with other competitors in the market, seems like a partner preference too. Regarding the proposition that respondents give similar answers to their observed barriers as their preferences when looking for a partner, this can be partly confirmed. Although a lot of elements do seem to differ, the commonness of trust being a barrier as well as a preference, shows that at least one element is similar.

5.2 Discussion

The study aimed to give SME's with little to no experience within industry 4.0, a first step on implementing industry 4.0 technology on the mid- to long-term. With this first step, insights about their collaborative network on collaborating in industry 4.0 settings will be feasible. Regarding this goal, several findings contribute a clearer understanding to existing literature.

First of all, Schumacher et al. (2016) and Müller et al. (2018) lay their focus on especially SME's that are uncertain about the impact Industry 4.0 has on their business model. The results of this study show that within the logistic sector, not only SME's but also bigger companies are uncertain on the impact of Industry 4.0 on their business model. This study contributes to Müller et al. (2018) that mention the current unpreparedness of most SME's towards industry 4.0 not only holds up for SME's, but also finds deeper reasoning for this. It seems companies with this current unpreparedness are still dealing with the digitalisation of their internal processes. While focusing on their internal processes, these respondents foresee a sequence as finishing internal processes first before crossing company borders. While this contributes to the findings of Masdefiol et al. (2016) that mention the level of automation as one of three concepts that will determine if the concept of industry 4.0 is feasible for a company, other findings of this study contradicts this finding and suggests a possible misunderstanding towards industry 4.0 in the

context of possibilities. Namely, a best case stood out and showed that while digitalising internal processes, collaborations in industry 4.0 context are indeed possible. This collaboration and a possible collaboration based on sharing loads in the network that came forward during the analysis, display the potential of platform strategies that do not necessarily require complete digitalised processes. The platform-based collaboration strategy builds upon the findings of Kagermann (2015) that shows that platform-based collaborations are one of the two key instruments for enhanced value creation in the age of Industry 4.0. Also, the deeper understanding towards the reasoning behind the unpreparedness and the potential solution possibilities, contribute to the further assessment of implementation steps within the industry 4.0 domain suggested by Müller et al. (2018).

Second, in relation to the analysed drivers, the results show that companies with little to no experience only foresee a user role within the context of Industry 4.0, which contributes to the connection Müller et al. (2018) found between motivation and experience within Industry 4.0. Seeing cost reduction and service level as key drivers builds upon existing theory of Palmer et al. (2012) that has similar findings. Third, considering the barriers, the results contribute a clearer understanding towards the finding of Masdefiol et al. (2016) on the level of automation as one of the three concept that determine the feasibility of Industry 4.0. The results connect the level of automation to the findings of Somapa et al., 2018 that name the accessibility, quality and usefulness of information as possible barriers for not engaging with SCV. Also, the results suggest a new insight in that market knowledge to play an important role considering the digitalisation of processes, as this knowledge needs to be aligned with IT. At last, partner preference results contribute to the common importance of trust when selecting potential partners. (Hagedoorn, 2006; Dekker, Gulati and Gargiulo in Dekker & Van den Abbeele, 2010; Barratt, 2004; Palmer et al., 2012; Dalmolen et al., 2015; Bronder et al., 1992; Emden et al., 2006). Especially information exchange and openness confirm the theory by Barratt (2004) that suggests these two elements to be important alongside trust. The results show that forming collaborations with competitors can eventually cross legal and/or ethical borders and raises discussion. In combination with trust, this result shows a relatively new element that provides deeper understanding into the ethical barriers of information exchange and the importance of it in combination with trust.

5.3 Practical implications

The results of the paper show some remarkable insight and deeper understanding into the field of industry 4.0 in collaborative settings. Comprehending this a first step on implementing industry 4.0 technology on the mid- to long-term for companies that experience a lack of concretization and unpreparedness towards it, the results show that these companies are not the only one. In the domain of logistics, a lot of companies are still lacking concrete action towards Industry 4.0. Although it is most of the time a board topic (trend push), the results suggest that feasibility of it lacks due to a digitalisation backlog or maybe a misunderstanding towards the possibilities. A best case within the research showed the potential of platform-based collaborations, even in domains like sustainability where most of the unprepared companies within Industry 4.0 would not see a link. By learning from the best case and bearing in mind the misunderstanding and deeper reasoning this research present, similar experienced partners could be approached. Considering the paper of Palmer et al. (2012) that suggest assimilation as the next step towards a collaboration after exploring, this would fit in utterly. Especially as some results of

the research show that less mature companies within industry 4.0 do not necessarily look for concrete solutions, but just “want to try”.

5.4 Limitations and future research

To explore the field of industry 4.0 in terms of collaboration, a qualitative study approach was applied. The qualitative approach proved to provide deeper understanding within the specific unit of analysis on this particular subject. Although two different measurement techniques have been applied that contribute to the validity of the research findings, it is hard to create a generalizable result. Not only for other industries but also for the industries within the unit of analysis, as for both industries only 4/5 respondents provided insights (single informant bias). Although these respondents are top managers within their industries and would most probably be suited as a representative image of their industry, a larger sample would be necessary to validate the found insights over the complete industry. To generalize the found insights to other industries within logistics, is also an interesting future research domain. By testing more industries, a generalizable answer on the logistic domain itself could be found. This could contribute to the current theory on logistics and industry 4.0.

The research focused on the implementation and concretization of industry 4.0 within the logistic industry. Within this research direction, the paper builds upon previous theory by Müller et al. (2018) that suggest to qualitatively asses further implementation steps for industry 4.0. In this context the research explored the field of industry 4.0 in context of collaboration as a potential first step in implementing it. Besides the arguments for choosing this direction, theory did not suffice in further options for assessing these implementation steps. However theory did not suffice, this does not imply that this direction is the correct or unaccompanied one. Research shows some clear insights and starting points for further assessing implementation steps, although other research directions for assessing them could suffice as well. Thus, further assessing implementation steps for industry 4.0 in the context of crossing company borders would be desirable. First of all, to build upon these paper’s findings and second for considering alternative routes for implementing industry 4.0. Moreover, new findings in this research direction would assist companies that struggle with the rapid technological pace and how it can affect their business model.

During the interview phase it became apparent that some respondents are coping with uncertainty about the legal and ethical borders considering sharing data through the supply chain. What are the limits when analysing data from different competitors and what are the exact rules for this? Examining the legal and ethical borders for collaborating and data sharing on industry 4.0 principles could lead to more certainty within companies that involve these questions. A very broad research direction which also seems a bit indefinite. Creating more certainty within this topic would also support the implementation of industry 4.0 as trust (one of the key barriers and partner preference) goes hand in hand with the uncertainty the respondents have when considering the legal and ethical borders.

At last, the research focussed on forward vertical collaboration only. During the analysis several platform-based collaboration solutions came along, that showed possibilities that go beyond a one-on-one collaboration. It would be interesting to observe this topic from a network perspective.

6 REFERENCES

1. Alias, C., Goudz, A., Jawale, M., & Noche, B. (2015, May). Generating a business model canvas for future-internet-based logistics control towers. In *Advanced Logistics and Transport (ICALT), 2015 4th International Conference on* (pp. 257-262). IEEE.
2. Audy, J. F., Lehoux, N., D'Amours, S., & Rönnqvist, M. (2012). A framework for an efficient implementation of logistics collaborations. *International transactions in operational research*, *19*(5), 633-657.
3. Barratt, M. (2004). Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal, 9*(1), 30-42. doi:10.1108/13598540410517566
4. Barratt, M., & Oke, A. (2007). Antecedents of supply chain visibility in retail supply chains: A resource-based theory perspective. *Journal of Operations Management, 25*(6), 1217-1233. doi:10.1016/j.jom.2007.01.003
5. Barreto, L., Amaral, A., & Pereira, T. (2017). Industry 4.0 implications in logistics: An overview. Procedia Manufacturing, 13, 1245-1252. doi:10.1016/j.promfg.2017.09.045
6. Bartlett, P., Julien, D., & Baines, T. (2007). Improving supply chain performance through improved visibility. *The International Journal of Logistics Management, 18*(2), 294-313.
7. Bleda J. (2014): *Prepare for Take-off with a Supply Chain Control Tower*. Podcast Transcript, Accenture, https://www.accenture.com/t20150523T032854__w__/us-en/_ acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_6 /Accenture-Supply-Chain-Control-Tower-Podcast-Transcript.pdf (accessed: 6.1.2019).
8. Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective. *International Journal of Mechanical, Industrial Science and Engineering*, *8*(1), 37-44.
9. Britten, N., Jones, R., Murphy, E., & Stacy, R. (1995). Qualitative research methods in general practice and primary care. Family practice, 12(1), 104-114.
10. Bronder, C., & Pritzl, R. (1992). Developing strategic alliances: a conceptual framework for successful co-operation. *European Management Journal*, *10*(4), 412-421.
11. Brouthers, K. D., Brouthers, L. E., & Wilkinson, T. J. (1995). Strategic alliances: Choose your partners. *Long range planning*, *28*(3), 2-25.
12. Cao, M., & Zhang, Q. (2013). *Supply chain collaboration: Roles of interorganizational systems, trust, and collaborative culture*. London: Springer. doi:10.1007/978-1-4471-4591-2
13. Co, H., & Barro, F. (2009). Stakeholder theory and dynamics in supply chain collaboration. *International Journal of Operations & Production Management,29*(6), 591-611. doi:10.1108/01443570910957573
14. Dalmolen, S., Moonen, H., & van Hillegersberg, J. (2015, February). Building a Supply Chain Ecosystem: How the Enterprise Connectivity Interface (ECI) Will Enable and Support Interorganisational Collaboration. In *International Workshop on Global Sourcing of Information Technology and Business Processes* (pp. 228-239). Springer, Cham.
15. Dekker, H. C., & Van den Abbeele, A. (2010). Organisational learning and interfirm control: The effects of partner search and prior exchange experiences. Organisation Science, 21(6), 1233-1250.

16. Doorewaard, H., Kil, A., & Ven, A. (2015). Praktijkgericht kwalitatief onderzoek: een praktische handleiding.
17. Emden, Z., Calantone, R. J., & Droge, C. (2006). Collaborating for new product development: selecting the partner with maximum potential to create value. Journal of product innovation management, 23(4), 330-341.
18. Eisenhardt, K. M., & Schoonhoven, C. B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *organization Science*, *7*(2), 136-150.
19. Evangelista, P., Sweeney, E. 2009. "The Role of Information and Communication Technology in Small Italian Logistics Enterprises". *International Journal of Business and Systems Research.* Vol. 3. No. 1. 1-18.
20. Francis, V. (2008). Supply chain visibility: Lost in translation? *Supply Chain Management: An International Journal, 13*(3), 180-184.
21. Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S. (2013). *Produktionsarbeit der Zukunft-Industrie 4.0* (pp. 50-56). D. Spath (Ed.). Stuttgart: Fraunhofer Verlag.
22. Ganzarain, J., & Errasti, N. (2016). Three stage maturity model in SME's toward industry 4.0. *Journal of Industrial Engineering and Management*, *9*(5), 1119-1128.
23. Gunasekaran, A., Ngai, E.W.T. 2003. "Information systems in supply chain integration and management". *European Journal of Operational Research.* Vol. 159. 269–295.
24. Gunasekaran, A., Ngai, E.W.T. 2003. "The successful management of a small logistics company". *International Journal of Physical Distribution & Logistics Management.* Vol. 33. No. 9. 825–842.
25. Hagedoorn, J. (2006). Understanding the cross-level embeddedness of interfirm partnership formation. Academy of management review, 31(3), 670-680.
26. Harrell, M. C., & Bradley, M. A. (2009). Data collection methods. Semi-structured interviews and focus groups. Rand National Defense Research Inst santa monica ca.
27. Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry, 89*, 23-34. doi:10.1016/j.compind.2017.04.002
28. Holweg, M., Disney, S., Holmström, J., & Småros, J. (2005). Supply chain collaboration. *European Management Journal, 23*(2), 170-181. doi:10.1016/j.emj.2005.02.008
29. Kagermann, H. (2015). Change through digitization—Value creation in the age of Industry 4.0. In *Management of permanent change* (pp. 23-45). Springer Gabler, Wiesbaden.
30. Kaipia, R., & Hartiala, H. (2006). Information-sharing in supply chains: Five proposals on how to proceed. *The International Journal of Logistics Management, 17*(3), 377-393.
31. Kazantsev, N., Pishchulov, G., Mehandjiev, N., Sampaio, P., & Zolkiewski, J. (2018, February). Formation of Demand-Driven Collaborations between Suppliers in Industry 4.0 Production Networks. In *PrePrints, 20th International Working Seminar on Production Economics, Innsbruck* (pp. 255-266).
32. Lambert, D., Emmelhainz, M., & Gardner, J. (1996). Developing and implementing supply chain partnerships. The International Journal of Logistics Management, 7(2), 1-18.
33. Liao, Y., Deschamps, F., Loures, E., & Ramos, L. (2017). Past, present and future of industry 4.0 - a systematic literature review and research agenda proposal. *International Journal of Production Research, 55*(12), 3609-3629. doi:10.1080/00207543.2017.1308576
34. Macaulay, J., Buckalew, L., & Chung, G. (2015). Internet of Things in Logistics; A Collaborative Report by DHL and Cisco.

35. Manthou, V., Vlachopoulou, M., & Folinas, D. (2004). Virtual e-Chain (VeC) model for supply chain collaboration. *International Journal of Production Economics, 87*(3), 241–250.
36. Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*, *13*(6), 522-526.
37. Martin, N., Verdonck, L., Caris, A., & Depaire, B. (2018). Horizontal collaboration in logistics: Decision framework and typology. *Operations Management Research: Advancing Practice through Theory,11*(1-2), 32-50. doi:10.1007/s12063-018-0131-1
38. Masdefiol, R., del Mar, M., & Stävmo, F. (2016). Industry 4.0–Only designed to fit the German automotive industry: A multiple case study on the feasibility of Industry 4.0 to Swedish SMEs.
39. Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Sage publications.
40. Morgan, T., Richey Jr, R., & Ellinger, A. (2018). Supplier transparency: Scale development and validation. *The International Journal of Logistics Management, 29*(3), 959-984. doi:10.1108/IJLM-01-2017-0018
41. Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International journal of qualitative methods*, *1*(2), 13-22.
42. Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, *132*, 2-17.
43. Naesens, K., Gelders, L., & Pintelon, L. (2009). A swift response framework for measuring the strategic fit for a horizontal collaborative initiative. *International Journal of Production Economics*, *121*(2), 550-561.
44. Nieuwenhuize, G. B. (2016). Smart Manufacturing for Dutch SMEs Why and How?. *Rotterdam school of Management–Erasmus University*.
45. Palmer, A., Saenz, M. J., Woensel, T. V., & Ballot, E. (2012). Characteristics of collaborative business models. *CO3 position paper*.
46. Salkind, N. J., & Rainwater, T. (2003). *Exploring research*. Upper Saddle River, NJ: Prentice Hall.
47. Schmoltzi, C., & Marcus Wallenburg, C. (2011). Horizontal cooperations between logistics service providers: motives, structure, performance. *International Journal of Physical Distribution & Logistics Management*, *41*(6), 552-575.
48. Schoenthaler, R. (2003), "*Creating real-time supply chain visibility*", *Electronic Business*, Vol. 29 No. 8, p. 12.
49. Schuh, G., Potente, T., Varandani, R., & Schmitz, T. (2014). Global footprint design based on genetic algorithms - an "industry 4.0" perspective. *Cirp Annals - Manufacturing Technology, 63*(1), 433-436. doi:10.1016/j.cirp.2014.03.121
50. Schumacher, A., Erol, S., & Sihn, W. (2016). A maturity model for assessing industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia Cirp, 52*, 161-166. doi:10.1016/j.procir.2016.07.040
51. Sheu, C., Yen, H. R., & Chae, D. (2006). Determinants of supplier-retailer collaboration: Evidence from an international study. *International Journal of Operations & Production Management, 26*(1), 24–49.
52. Somapa, S., Cools, M., & Dullaert, W. (2018). Characterizing supply chain visibility - a literature review. *International Journal of Logistics Management, 29*(1), 308-339. doi:10.1108/IJLM-06-2016-0150
53. Stebbins, R. A. (2001). Exploratory research in the social sciences (Vol. 48). Sage

54. Strandhagen, J., Alfnes, E., Strandhagen, J., & Vallandingham, L. (2017). The fit of industry 4.0 applications in manufacturing logistics: A multiple case study. *Advances in Manufacturing, 5*(4), 344-358. doi:10.1007/s40436-017-0200-y
55. Strauss, A., & Corbin, J. (1990). *Basics of qualitative research*. Sage publications.
56. Struiwigh, P. (2012). *Supply Chain Orchestration by Logistics Service Providers. Do company size and ownership of assets matter?* (Master's thesis, Open Universiteit Nederland).
57. Trzuskawska-Grzesińska, A. (2017). Control towers in supply chain management–past and future. *Journal of Economics & Management*, *27*, 114-133.
58. Van Breedam, A., Krols, K. L., & Verstrepen, S. (2005). Logistiek samenwerken praktisch bekeken.
59. Vanpoucke, E., Vereecke, A., & Muylle, S. (2017). Leveraging the impact of supply chain integration through information technology. *International Journal of Operations & Production Management,37*(4), 510-530. doi:10.1108/IJOPM-07-2015-0441
60. Vasconcelos, D. M. D., & Kaminski, P. C. (2014). Development of a supplier and purchase order management product/service under the 4PL logistics concept: a case study. *Product: Management & Development*, *11*(2), 125-135.
61. Verstrepen S, Cools M, Cruijssen F, Dullaert W (2009) A dynamic framework for managing horizontal cooperation in logistics. Int J Logist Syst Manag 5(3–4):228–248
62. Webster, J., & Watson, R. T. (2002). "Analyzing the past to prepare for the future: Writing a literature review". MIS quarterly, 26(2), 13-23.
63. Whipple, J. M., & Frankel, R. (1998). The alliance formation process. *The International Food and Agribusiness Management Review*, *1*(3), 335-357.
64. Yan, W. J., Tan, P. S., Koh, N. W., Tan, Y. Q., & Zhang, A. N. (2012, December). Towards better supply chain visibility—The design and implementation of a supply chain system S-ConTrol to support an operational HQ in Singapore. In *Industrial Engineering and Engineering Management (IEEM), 2012 IEEE International Conference on* (pp. 971-975). IEEE.

APPENDIX 1: INTERVIEW GUIDE

Interview

During this interview we discuss several components of collaboration. All these components of collaboration are focussed on industry 4.0 settings. We think the following definition suits the term its best: “Recent technological advances where the internet and supporting technologies (e.g. embedded systems) serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organizational boundaries to form a new kind of intelligent, networked and agile value chain.” In concrete terms this could encompass solutions like control towers, end-to-end track and trace or CO2 friendly solutions like reducing empty kilometres by sharing data. Of course, industry 4.0 offers way more concrete solutions, but all solutions have in common that they create some sort of supply chain visibility. This is exactly in which context the following questions will be asked.

Collaborative experience

1. Do you have any experience in collaborations based on industry 4.0 settings?
   - If yes, can you tell us more about it?
   - If no, can you tell us what you know about industry 4.0?

2. How far are you in collaborating or developing in industry 4.0 settings?

Drivers of collaboration

3. What are your main drivers for collaborating by industry 4.0 settings?
   - Could you rate this/these driver(s) from 1 till 10 on their importance?
   - One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?

4. Second, these questions are based on a paper of Palmer et al. (2012)

   DRIVERS
   Cost reduction
   Demanding customers
   Service level
   Increased differentiation
   Increased competition
   Increased regulation
   Reduce CO2
   Sustainability

   - Do you recognize yourself in one of these drivers?
   - Could you rate all these drivers from 1 till 10 on their importance?
   - One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?

Partner preferences

5. What are your preferences when searching for a partner to collaborate by industry 4.0 settings?
   - Could you rate this driver from 1 till 10?
   - One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?

6. The following questions are based on the partner selection elements beneath.

1. Cultural fit
- ❖ **Trust**
- ❖ **Familiarity**
- ❖ **Mutuality/ fundamental fit**
- ❖ **Information exchange**
- ❖ **Openness**

2. Strategic fit
- ❖ **Compatible goals/ corporate focus**
- ❖ **Commensurate levels of risk**
- ❖ **Top management characteristics/ key people**
- ❖ **Financial strength**
- ❖ **Business case**
- ❖ **Intra-organisational support**

3. Technological fit
- ❖ **Complementary skills**
- ❖ **ICT integration**
- ❖ **Technological ability**
- ❖ **Market knowledge**

4. Collaborative environment
- ❖ **Collaborative experience**
- ❖ **Drivers of collaboration**
- ❖ **Partner preferences**
- ❖ **Perceived barriers**

   - Do you recognise yourself in one of these elements?
   - Could you rate these elements on a scale from 1 till 10 on their importance?
   - One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future

Perceived barriers

7. What barriers came forward while collaborating in industry 4.0 settings?
8. Or in case of no experience: What do you think are the barriers that will arise?
    - Could you rate these barriers from 1 till 10 on their importance?
    - One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future? (per barrier)

9. The following questions are based on the barriers found beneath

    1. **Need for supply chain visibility**
        - ❖ **Bad availability of information**
        - ❖ **Bad accessibility of information**
        - ❖ **Bad quality of information**
        - ❖ **Bad usefulness of information**

    2. **Culture**
        - ❖ **Lack of trust**
        - ❖ **No aligning business strategy**
        - ❖ **Missing key people/leaders' mindset**
        - ❖ **Bounded rationality**

    3. **Technological knowledge**
        - ❖ **Technological impediments**
        - ❖ **Lack of scalability towards technology**
        - ❖ **Too low level of automation**

    4. **Financial status**
        - ❖ **Too much financial effort**
        - ❖ **Switching costs**
        - ❖ **No solid business case/impact**

    - Do you recognise yourself in one of these barriers?
    - Could you rate these barriers on a scale from 1 till 10 on their importance?
    - One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?

APPENDIX 2: FOCUS GROUP GUIDE

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

- If yes, can you tell us more about it?
- If no, can you tell us what you know about industry 4.0?

How far are you in collaborating or developing in industry 4.0 settings?

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

Second, these questions are based on a paper of Palmer et al. (2012)

DRIVERS
Cost reduction
Demanding customers
Service level
Increased differentiation
Increased competition
Increased regulation
Reduce CO2
Sustainability

- Do you recognize yourself in one of these drivers?

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

The following questions are based on the partner selection elements beneath.

1. **Cultural fit**
   - **Trust**
   - **Familiarity**
   - **Mutuality/ fundamental fit**
   - **Information exchange**
   - **Openness**

2. **Strategic fit**
   - **Compatible goals/ corporate focus**
   - **Commensurate levels of risk**
   - **Top management characteristics/ key people**
   - **Financial strength**
   - **Business case**
   - **Intra-organisational support**

3. **Technological fit**
   - **Complementary skills**
   - **ICT integration**
   - **Technological ability**
   - **Market knowledge**

4. **Collaborative environment**
   - **Collaborative experience**
   - **Drivers of collaboration**
   - **Partner preferences**
   - **Perceived barriers**

Do you recognise yourself in one of these elements?

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

Or in case of no experience: What do you think are the barriers that will arise?

The following questions are based on the barriers found beneath

1. **Need for supply chain visibility**
   - **Bad availability of information**
   - **Bad accessibility of information**
   - **Bad quality of information**
   - **Bad usefulness of information**

2. **Culture**
   - **Lack of trust**
   - **No aligning business strategy**
   - **Missing key people/leaders' mindset**
   - **Bounded rationality**

3. **Technological knowledge**
   - **Technological impediments**
   - **Lack of scalability towards technology**
   - **Too low level of automation**

4. **Financial status**
   - **Too much financial effort**
   - **Switching costs**
   - **No solid business case/impact**

Do you recognise yourself in one of these barriers?

APPENDIX 3: INTERVIEW INVITE

Dear (respondent),

Together with universities we are doing research in different business and management topics. One of these researches is with the University of Twente and focusses on collaborations based on industry 4.0 theory, to provide more insights in this particular topic! My name is Dennis Schreinders and I am a graduate student from the university of Twente that is responsible for this particular research.

We would appreciate it if you could make time to sit together with us, to improve each other on the field of collaborations. The interview will take approximately half an hour of your time. For now, we provide you with a short introduction, where the context of the interview will be acquainted.

“During this interview we discuss several components of collaboration. All these components of collaboration are focussed on industry 4.0 settings. We think the following definition of industry 4.0 suits the term its best: “Recent technological advances where the internet and supporting technologies (e.g. embedded systems) serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organizational boundaries to form a new kind of intelligent, networked and agile value chain.” In concrete terms this could encompass solutions like control towers, end-to-end track and trace or CO2 friendly solutions like reducing empty kilometres by sharing data. Of course, industry 4.0 offers way more concrete solutions, but all solutions have in common that they create some form of supply chain visibility. This is exactly in which context the questions will be asked. The questions are divided into two categories namely the collaborative environment you are acting in and collaborative components your company deals with.”

William Emons made contact with you in the past days to discuss why we want you to participate in this research. The interview will be held preferably face-to-face with William and I, whereas the interview will be used for research purposes only. Also, the interview assures confidentiality. Your name and the company name will not be mentioned in the research itself and the interview will not contain compromising questions.

We hope to see each other soon! For questions you can always contact me or William. My contact information is mentioned below. For William you can email him at: w.emons@emons.eu.

With kind regards,

Dennis Schreinders

University of Twente

Graduate intern at Emons Group

Telnr: +31614368277

APPENDIX 4: INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
I understand that taking part in the study involves that my answers are audio recorded and transcribed as written text. The audio will be destroyed after submission of the thesis in June 2019.	☐	☐
Use of the information in the study I understand that information I provide will be used for the researcher's master thesis.	☐	☐
I understand that personal information collected about me that can identify me, such as my name, my employer or any contact data, will not be shared by the researcher.	☐	☐
I agree that my information can be quoted in research outputs.	☐	☐

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

APPENDIX 5: INTERVIEW TRANSCRIPTS

Interview 1

Name: Participant A
Gender: Female
Function: Logistic manager
Industry: Glass industry

Date: 18-04-2019 Length: 58:35
Language: German
Source of Contact: Emons
Type of interview: Face-to-face

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

There is experience, yet not in logistics but in the production area. Although it still focusses on digitalisation, which makes it more look like industry 3.0. Not industry 4.0.

- ***If yes, can you tell us more about it?***

Not applicable.

How far are you in collaborating or developing in industry 4.0 settings?

At the moment this is a very hot topic inside the company. Especially in logistics. It's a board topic even. At the moment we have a trainee that focusses on industry 4.0 as well. We just want to see and try, with the data we have, what we can do with it, how we can use it, to make the business more efficient. We are looking in both ways, for example to our customers but also to our suppliers. On this theme we have built a 1,5-year plan, to see what this brings to us. Also, we are looking at ways to digitalise things we are currently doing manually. This again is more industry 3.0.

You said customers and suppliers, can you elaborate more on this?

At this moment it's more focussed on logistic management, order management and planning. We are currently looking into a machine that asks every two hours before due time, asks himself where he is and if he's going to be on time or how much over time. The question is if this can be seen as industry 4.0 or just digitalisation. Before we can look into industry 4.0, we want to establish a solid base of digitalisation inside the company and with our data.

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

At the moment it's more of an internal motivation rather than customers or suppliers that demand us to work on this topic. No company came to us and asked for certain data they want to work with to create visibility. I can just talk for the department of logistics so maybe that is the case within the production environment, but as far as I know: no. Sure for us, as I work for already 10 years in this department, we always looking for ways to make our doings more efficient. We noticed that the business throughout the years became more complex. One of our priorities was always to make this less complex and one of those ways is to investigate industry 4.0 as data sharing. A lot of things are still being done manually and this is

going beyond our system landscape. At the moment this is not a real big deal. But in the future, I think this could be a huge advantage for us if we did do this like this.

So, this can be seen as the key driver?

Yes, the market. The future. If we look at the future and the people that come after us, that is going to be a digital generation. So, we have to prepare ourselves for that. We are digitalising the data so that in the near future people can do something with it. For example, we have someone working with us that walks into the plant and scans data to fill this is afterwards manually. I think this can be done differently even 10 years ago. How is it possible that I have to send someone inside the warehouse to look for certain items? That sounds like industry -1. We know there is technology available nowadays that can solve this problem, so that's why we are looking into this.

And is this something your customers also asking for, or is this still internal?

I don't know if our customers are asking for this, because I'm not in direct contact with them. We have contact with our sales department and our sales department have contact with our customers.

Would you think this is something you can solve on your own, or do you think that a collaboration would help to better this?

I think to establish the solid base and to make sure that every data is digital available we only need ourselves. This is something we must do in house. If the data is valid and reliable, we will absolutely look outside our borders. I believe that that is the way to really work with industry 4.0 and to establish data visibility. Data have to be shared between customers and suppliers, but I do think someone with know-how needs to be there to create this data sharing. Not someone who think he can do this by focussing only two hours per day on this data sharing.

Second, these questions are based on a paper of Palmer et al. (2012)

- ***Do you recognize yourself in one of these drivers?***

What I just spoke about, the future, is something that affect our organisation structure. For example, there was one company in the near past, a big warehouse, that totally missed the online world. This had a huge impact on their existence. This is something we watch for, so that this does not happen to us. This can might be seen as increased differentiation and might more a way of a safe and stable future for our company. And for example, demanding customers could be such a driver. But more in a question that will customers still ask for us in the future rather than are they asking more for us in the future.

Increased regulation is also important to us. We see this happening for example with ISO certifications but also regulations within traffic. Also, data protection and safety are an important topic.

Process optimisation is also a driver for us that is not attached to this list. Because I think that working with data is a way to optimise the process of us.

- ***Could you rate all these drivers from 1 till 10 on their importance?***
- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Cost reduction 8 - 8

Demanding customers 9 - 10

Service level/ future 9 - 10

Increased differentiation 9 -10

Increased competition 8 - 9

Increased regulation 7 -7

Reduce CO2 6 - 6

Sustainability 6 -6

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

Within industry 4.0 context it is not experience what we would look for. Because it would probably not be there. Maybe a start-up for example. For us it would be important if the partner would be open, would admit that he wants to grow into the subject himself too. With this you can try together what possibilities and options would arise. For example, if we check out RFC chips. It would be nice if a supplier came to us with one chip and asked: can we try on this? The willingness to grow together is very important. At the moment I think it would be very hard if a company comes up to us with a standard solution. This would probably not fit as I think this requires huge customisation.

Also, we would need to someone with market knowledge. So general know-how. Not specifically in industry 4.0, but more in what the requirements are and where to get them. We are in a current stage where we are thinking, we just want to try. Because we are not so sure about things either. And before I buy, I want to know if it works yes or no.

The following questions are based on the partner selection elements.

- ***Do you recognise yourself in one of these elements?***

We just spoke about general know-how. I think this belongs to technological fit as market knowledge. This would be very important to us. But only that, not the solution itself. When for example two

firms want to share data; a third party could help with the technological know-how in how to share and how to present etc.

When we look into the cultural elements, this is also what we spoke about. The openness of the company, trust and information exchange is very important in this topic.

Familiarity is not necessary. A start-up is also cool to try. The same goes for mutuality. A company does not necessarily have to see the same profit in it.

At the start the financial strength of a company does not have to there. The solution is more important. Later when the solution is there, it does become more important because the company must have the strength to solve an important problem that can arise.

The intra-organisational support is also very important. If the potential partner cannot deliver enough support for the possible solution, the partner does not even have to start. Also, a business case needs to be there. If not so, we cannot start as the board would not approve.

Service level and processes need to fit with our company. Service we already spoke about and processes would be nice to be aligned. However, the size of the company does not influence the choice in my opinion. The same goes for partner characteristics.

- ***Could you rate these elements on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future***

Trust 8 – 10

Familiarity 1 - 1

Fundamental fit 5 - 5

Information exchange 10 - 10

Openness 10- 10

Compatible goals 5 - 5

Commensurate levels of risk 5 - 5

Key people 5 - 5

Financial strength 4 - 7

Business case 9 - 10

Intra-organisational support 6 – 8

Complementary skills 6 - 6

ICT integration 5 - 5

Technological ability 6 -6

Market knowledge 9 – 10

Size 1 - 1

Product characteristics 1 -1

Process 7 - 7

Service level 8 - 9

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

Not applicable

Or in case of no experience: What do you think are the barriers that will arise?

The know-how of the personnel that must work with a potential solution. At least this a big challenge to get everyone to understand it. Quiet for a while….

The following questions are based on the barriers found beneath

- ***Do you recognise yourself in one of these barriers?***

As told missing key people to help the personnel with the upcoming future and solutions.

Too much financial effort is definitely a barrier I would think of. When from the start the effort is too high, it would not go through the board. When we are talking about barriers that arise will starting such a collaboration, no solid business case would mean a definite no. why would we start something when there is no business case. On the other hand, when a collaboration is started, this would not be a barrier. Because this is already cleared before starting.

Also, trust is absolutely a barrier. When we work with highly sensitive data this needs to be secure. Absolutely a no go if not there. All the things about supply chain visibility are sure barriers. When you want to work with data sharing the data needs to be good. This is a driver but also a barrier. As already said before, data inhouse needs to be valid first before crossing company borders. Digitalisation is a must. The data platform needs to be organised.

So, you would that at this moment the valid basis is not there?

Yes absolutely. This needs to be done first. When we are ready, we have plans and concepts in storage that will help us with the following steps with the goal of creating more visibility throughout the supply chain.

So, is going industry 4.0 going too fast or is your company lacking speed?

I don’t think we are too late. We have several master thesis students that think about this subject. We are too late with the digitalisation. Yes, there is digitalisation, but certainly not enough. The possibilities to work with this data is already there. Yet the data is lacking. What information is important, what not. These are questions we are still dealing with. The data gathering itself is not really the point. On production level we are doing better, but on logistic level this can definitely improve.

- ***Could you rate these barriers on a scale from 1 till 10 on their importance?***

- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?***

Bad information 9 – 9

Lack of culture 9 - 10

No aligning business strategy 6 - 6

Missing key people / leaders' mindset 9 – 10

Bounded rationality 8 - 9

Technological impediments 6 - 8

Lack of scalability 2 -2

Too low level of automation 9 -9

Too much financial effort 9 -10

Switching costs 2 -2

No solid business case 9 – 10

Interview 2

Name: Participant B	**Date: 18-04-2019 Length: 45:25**
Gender: Female	**Language: German**
Function: Transport manager	**Source of Contact: Emons**
Industry: Glass industry	**Type of interview: Face-to-face**

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

From my experience little to no experience. However, the theme is very actual at the board and in the company. We are currently trying to establish working groups to see what possibilities are there and one which places we can bring the automatization to another level. At the moment this is more focussed on the internal part of the company rather than logistics, that's why I'm not that experienced in collaborations based on industry 4.0.

- ***If yes, can you tell us more about it?***

Not applicable.

- ***If no, can you tell us what you know about industry 4.0 in collaborative context?***

At the moment more theoretical information. We are currently gathering ideas about the subject, what possible solutions we can think of without knowing if this is practically possible. So pure gathering ideas.

Later on, we will see how we can bring this into practice and with sharing data from outside the company. So, what IT solutions would be necessary is something we don't know. As logistic department we have to deal with different parts of the network. For example, our customers but also our suppliers and logistic service providers. At the end we hope to gather data through the whole supply chain starting at the supplier and going from our company to logistic service providers to customer etc. All this information that can be connected is what I see as industry 4.0.

So, if you think about industry 4.0 you think about sharing data?

Yes. When I think about industry 4.0, I think about sharing data and how to use the data in a smart way. At the end this is done with the goal of improving our service and from our network.

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

As we spoke about the practical part of industry 4.0. our drivers would be minimalizing costs, minimalizing writing/gathering time. At the moment we are still gathering so much data manually. That also makes us good because we are sharing this in our company, but still I think we can do much better when we would prepare things in advance.

So, you call this working more efficient?

Yes.

Second, these questions are based on a paper of Palmer et al. (2012)

- ***Do you recognize yourself in one of these drivers?***

Absolutely. For example, cost reduction as I just mentioned and service level. Working more efficient would improve our service level. Also, for example, at our department are currently working six employees. With all the new techniques in the future we can might do it with two or three. This will save us definitely costs. When we see it from the other side, every year we have more and more problems with finding personnel for the company. Working more efficient will help us as we won't need as much people in the future.

Also, sustainability and reducing CO2 in mind our suppliers are actually giving us the base for working this way. Working more efficiently from the start of the supply chain reduces the effects of CO2. When I look at us, I think we can do more, and we should do more. For example, the transport that you are delivering us could be used more efficiently. Also, for the transport we take into account the sustainability of that company. When we would watch in industry 4.0 context, this would also be an element.

Looking at demanding customers, this is also very important to us. One of the greatest advantages of our company is that we can still modify and change the orders of our customers. To keep this advantage and to become better on this point as customers demand for more and more flexibility, industry 4.0 could help us a lot.

- ***Could you rate all these drivers from 1 till 10 on their importance?***

- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Cost reduction 8 - 9

Demanding customers 9 - 9

Service level/ future 9 -9

Increased differentiation 5 - 10

Increased competition 5 -5

Increased regulation 6 - 6

Reduce CO2 7 - 8

Sustainability 7 -8

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

I have been thinking about this some time as you already send this question and I think it's a hard one. The partner needs to be aware of the fact to they own more information about the supply chain than at the moment. Which means that the trust needs to be very high. Also, the partner should have the ability to think ahead. With all the data they would potentially have to could think about delivering transport possibilities in advance. Now we have to call for a lot of these issues, which could potentially be done in advance. Market knowledge therefore is a must.

The following questions are based on the partner selection elements.

- ***Do you recognise yourself in one of these elements?***

As being said, trust is important. Maybe not as much for the managing directors but more for the people that work with the data. On operational level. For the managing directors the base is trust, after this is established this is not an issue anymore. Actually, all points in the cultural fit are important, I think. This is just the basis for collaboration. When sharing information with a partner, it is important that he gives access to all relevant information. So, if things still remain secrets the collaboration would not work. So, openness and trust are very important. For the future the fundamental fit is also important. If the partner wants to develop in another direction than us with the same data this would probably not work. So compatible goals are important. Which could be the same as fundamental fit.

Financial strength is not something we would look for. But a strong business case is important. When there is no business case there is no reason to start. Also, the intra-organisational support is important as close contact between partners is necessary when sharing data.

Also, the third point: technological fit is important. The possible partner needs to be ready on technological level to work together. Does he have the data available to share and to link. For example, I don't know if this is currently possible between us, because we are both working with terrible systems

(funny example). But the data should never be used against each other. That is something that needs to be taken into account. For example, if we look at you as a supplier, you also have other competitors in the glass industry as customers. What will you do when you have partnerships like this with more than one customer? Innovation level of the partner is also important to us, so that we will not stay behind in innovation. This could be seen as technological ability. Operational fit is not something I would look for when searching for possible partners.

But does the potential partner need to have more technological knowledge than your company?

No that not necessarily. It is important that he can exchange data. There are probably systems that can help with exchanging data between two systems, so that is not the problem, I think.

- ***Could you rate these elements on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future***

Trust 10 - 10

Familiarity 5 - 5

Fundamental fit 7 - 9

Information exchange 10 -10

Openness 10 - 10

Compatible goals 7 - 9

Commensurate levels of risk 1 -1

Key people 6 -6

Financial strength 1 -1

Business case 8 - 8

Intra-organisational support 9 -9

Complementary skills 7 - 7

ICT integration 5 -5

Technological ability 7 - 8

Market knowledge 8 - 9

Size 1 -1

Product characteristics 1 -1

Process 1 - 1

Service level 1 -1

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

Not applicable.

Or in case of no experience: What do you think are the barriers that will arise?

When the board of the company would say we only focus on intern and not on extern when working with industry 4.0. This would definitely be a showstopper. When the possible partner goes another direction than we would like to go with industry 4.0. As already discussed in the previous section. Also, I could imagine that technological improvement of a company could be a barrier. If a company does not want to improve on this particular subject, it's a no go. Also, people could be a barrier. Employees that work within our company on operational level, could have problems with working with all this information and sharing of data and when sharing information with a partner, it is important that he gives access to all relevant information. So, if things still remain secrets the collaboration would not work.

The following questions are based on the barriers found beneath

- ***Do you recognise yourself in one of these barriers?***

Missing key people and bounded rationality are points that I just discussed, I think. When the management takes other decisions and if people inside the company cannot work with it, these would be the barriers. No business strategy is in line with what we discussed in the previous section. This could make us stop a collaboration. Also, if the board would interfere, no aligning business strategy would be a barrier.

If the data that needs to be shared is not accessible and not of the correct quality, it is impossible to work together. Actually, all barriers that are mentioned are kind of important.

Because I could also imagine that the technological knowledge could form a problem. Systems need to be matched so well. If this is not done properly the best system is useless. We have seen this with a system we tried to implement here. It just didn't work. Nobody could work with it and in the end, people were so annoyed that they did not want to work with it anymore. At the end the management cancelled it.

In a healthy organisation there are of course limits when it comes to the financial issues. But I think that if there is a solid business case a company is ready to invest in these things. So, in the future this would become less of a problem.

- ***Could you rate these barriers on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?***

Bad information 9 -10

Lack of culture 9 -9

No aligning business strategy 7 -10

Missing key people / leaders' mindset 9 -9

Bounded rationality 9 - 10

Technological impediments 8 - 9

Lack of scalability 4 - 4

Too low level of automation 8 - 8

Too much financial effort 5 - 5

High switching costs 1 -1

No solid business case 9 – 9

Do you think there is something missing when looking at the context these questions are asked, namely mapping the attitude of companies towards industry 4.0 and collaborations?

No, I don't think so. It is very general. But the topic is at the moment also general. We as customers are maybe thinking more specific in solutions. I'm now speaking on behalf of the transport department, but someone from the production department would think of line optimisation. But focussing on the general topic is an interesting choice.

Interview 3

Name: Participant C
Gender: Male
Function: Regional supply chain manager
Industry: Glass industry

Date: 24-04-2019 Length: 60:45
Language: Dutch
Source of Contact: Emons
Type of interview: Face-to-face

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

At the moment very little. Some colleagues of mine starting with this in the production department and in the warehouse department. I don't know about the ins and outs in the production department, but in the warehouse department we are talking about where I stall my products, how do I mix them, how do I make sure I work as efficient as possible. So maybe it's like warehouse management based on data. We started

with a pilot to see what it brings us. All I know about the production warehouse is that they are trying to collect data in a smart way, so that things don't have to be think of twice.

So, at this moment it is more focussed on collecting data?

Yes, that's true.

And this focus is on inhouse?

Yes, although with the help of a third party. No more elaboration on this matter.

- ***If yes, can you tell us more about it?***

Not applicable.

Can you tell us about industry 4.0?

For me, industry 4.0 has more directions. A fully automated warehouse is what I saw already multiple years ago. I also think using data on an intelligent way so that work can be easier. For example, we are always delivering something late at a customer. Why is that? Because we are in this traffic jam at a particular time. So, what if we knew all about these traffic jams, maybe we can make sure this customer does not make the order a specific time so that we are not in this traffic jam. These forms of data could be used very useful. Its maybe very basic data, which may lay somewhere outside the borders of our company, but we could do so much with it. Data visibility and using it an intelligent way. We are currently collecting a lot of data, but are we using it in a smart way?

You are talking about data from outside of the company, can you elaborate more on this?

Yes. For example, how does the app Waze know that if I leave tomorrow at 9, I probably should leave 20 minutes earlier because of a traffic jam. Most of the times is even right. So probably they have more intelligent than traffic information that we have. This is a very basic example, but I believe that there is way more possible than this with data from outside of the company.

How far are you in collaborating or developing in industry 4.0 settings?

At the moment its more of interest in the topic from myself rather than doing something with it. In conversations with colleagues these things are discussed sometimes, but not more than that. It also is a board topic, as its one of the strategic agenda points.

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

Kind of the things I just mentioned. If eventually things go further than the human mind and artificial intelligence related data can make us better, it becomes interesting. But the point I'm trying to make is that it should be a clear business case. What brings it to us? We also have a development department that is obviously further than the production department considering technology. But what is the business case of this technology? That is something that people in the rest of the firm does not see so clearly.

So, you call this working more efficient?

Yes.

Second, these questions are based on a paper of Palmer et al. (2012)

- ***Do you recognize yourself in one of these drivers?***

Cost reduction for sure. Because working efficiently makes sure we can reduce our costs. Demanding customers also. With the previous mentioned example this fits in perfectly. When we can better forecast what our customers want, we can serve them better. Also, service level is important to us. In the end money needs to be earned. Increased competition is less of an issue. I think in our market it's not about what we make, but how we offer it. So, if our competition is doing more, that is not our concern directly. Reduced CO2 and sustainability are important topics to us, but not in industry 4.0 context. Increased regulation is also not a link I would see directly. First of all, it is something we want to clear inhouse. Gain knowledge about it ourselves and then look outside our borders. That's maybe also because our industry is very conservative. If we talk about being innovative, we will not be the company that is on the first line.

Why would you think that?

Maybe it is fear for the unknown. Also, we would like to think that we are different than others in that we don't need to be like that. Sometimes we think we're good enough on our own.

- ***Could you rate all these drivers from 1 till 10 on their importance?***
- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Cost reduction 10 - 10

Demanding customers 9 - 9

Service level/ future 10 - 10

Increased differentiation 6 -6

Increased competition 5 -5

Increased regulation 1 -1

Reduce CO2 1 -1

Sustainability 3 -3

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

I don't know if I'm the person that can make those choices if it really comes to a collaboration. It's a very personal question in that case. The credibility is something I would watch for. Have they shown already what they can do on this level? Do they understand the thing itself? So, market knowledge is important. Also trust needs to be at a certain level. It needs to be a company that can work with full honesty with the

data that becomes available for them. Because this data is also sensitive for the other competitors that for example our supplier works with.

With one partner we do work with forecasts. As sharing directly of the availability of them for example. These are small things, but it does work so that's a funny but also interesting thing. This is also a trust related issue. We see everything from them. That's something that has to be taken into account. We are not controlling them, that's not the case. But the question is when is this going too far? Knowing things from the market could also raise false competition. When are influencing the market and when is this smart working? For example, booking.com, if you are looking for a hotel, the prices raise after you look for its multiple times. Maybe there is a difference between using public data or private data. It's also interesting how long you can keep track of your own product. In our company we know where our glass is, but as soon as it reaches the truckdriver we lose our track and our supplier takes over. That information would also be interesting for us. Even one step further as it reaches our customer and what he does with it. This data going through the whole supply chain is very interesting data which can be used in a more intelligent way, but therefore collaboration on this data is important.

The following questions are based on the partner selection elements.

- ***Do you recognise yourself in one of these elements?***

As we mentioned before, trust and business case are very important. Just as market knowledge. Know-how about the subject. Also, mutuality is important to us. Does the company think about this the same way as we are thinking? Actually, al point on this list are interesting. When you see it, you think yes, it is logical that these points are on the list.

If there is not a real connection with the possible partner, the rest can be so good, but it will probably not work. So, culture is very important. Although it does not say that the rest is not important. For every element I can give an example. So, I think this is a difficult question. In my experience it is very important that there is someone that can translate the IT solution to our specific business and level. This translation is key. So, a combination between Technological ability and market knowledge is very important.

- ***Could you rate these elements on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future***

Trust 10 – 10

Familiarity 6 - 6

Fundamental fit 9 – 9

Information exchange 9 – 9

Openness 10 – 10

Compatible goals 8 - 8

Commensurate levels of risk 8 - 8

Key people 9 - 9

Financial strength 1 - 1

Business case 10 - 10

Intra-organisational support 8 - 8

Complementary skills 8 - 8

ICT integration 6 - 6

Technological ability 10 - 10

Market knowledge 10 -10

Size 1 - 1

Product characteristics 6 - 6

Process 6 - 6

Service level 8 - 8

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

-

Or in case of no experience: What do you think are the barriers that will arise?

You live with the order of the day. You need to make time off to work on those ideas. I think that's with a lot of them. As long as there is no clear business case it won't be of a high priority, also because it is kind of the unknown.

We are using SAP, so we gather a lot of data. Also, consultants come up with wild ideas based on that data, be find difficulties with translating this to practice. So we are digitalized, the question is what we can do with it. Let's make clear, it is not that we are doing nothing with it. Small openings are formed, but I think it could be more. For example, about our customers we know actually a lot, but in small steps. We don't see a big bang coming out of this trend.

The following questions are based on the barriers found beneath

- ***Do you recognise yourself in one of these barriers?***

I can say with what of these points we find difficulties with. SAP is great, if you can get the information out of it. So, the accessibility of the data is a point we are dealing with. Also, are we all working with the same data. If I talk to our suppliers, do we talk about the same data? Constantly talking about the differences is a waste of time. We can better talk about the things that are in line to make that part more efficient. That's more than just a thing. Availability, no. There is enough. But accessibility, quality or usefulness are point that really can be better. That also makes this a driver as a barrier. Because this is what we would like to improve, but also keeps us from starting because it is not right yet. In the supply chain information is always a necessity.

I have glass in the warehouse that is not being sold, but it just stands there. We can easily see for which customer this was made, but not the reason why it's been made. That something I could easily 'throw' an industry 4.0 technology against it. With that we can make quicker links and make sure this will be cancelled quicker or used in a different way.

So why is it that you don't do this?

Money is not an issue for us. A full agenda is the main reason in most of the cases. So, a solid business case is something that misses. Not the financial resources. Also, trust can be an issue for our company. In history we had some issues on IT related subjects, so we are shuddered about the consequences of bringing new IT concepts in. That's definitely a thing. Just act normal so we can send our shipment tomorrow. Also, the technological knowledge is something behind. If we talk about the standard IT things we are very up to date, but if we look at production and warehouse management, we do have our issues. And we are not in the latest version of SAP with all the functions and options.

Could you rate these barriers on a scale from 1 till 10 on their importance?

- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Bad information: not the reason for not starting it, but why is not started yet.

Lack of trust 10 - 10

No aligning business strategy 5 -5

Missing key people / leaders' mindset 9 - 9

Bounded rationality 8 - 8

Technological impediments 5 -5

Lack of scalability 5 -5

Too low level of automation 5 - 5

Too much financial effort 1 -1

High switching costs 1 -1

No solid business case 10 - 10

Do you think there is something missing when looking at the context these questions are asked, namely mapping the attitude of companies towards industry 4.0 and collaborations?

No, I don't think so. It would be interesting to see in case of Emons, our supplier, if they have a solution like this: what would it bring us, a clear example of this. But in the end is a great first step to see what experience in the market is there, so that the possible solutions of for example Emons can focus on this information.

Interview 4

Name: Participant D
Gender: Male
Function: Logistics manager
Industry: Glass industry

Date: 08-05-2019 Length: 50:32
Language: English
Source of Contact: Emons
Type of interview: Face-to-face

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

- ***If yes, can you tell us more about it?***

As a company we are constantly transforming. We are always looking at trends and trying to improve ourselves with less resources. And I think industry 4.0 is a way to do that. Using Transporion is a perfect example of that.

If you are implementing something in your workstream, you got to engage with workstream from other stakeholders. So, from a customer service point of view, you must be very clear of the advantages. One of those experiences is coming from supply chain visibility and creates a whole new customer experience. Like more information, more accurate information that can bring to their own customers.

So, from you point of view this is about information sharing?

No not only information sharing. This is one of the things. We also wanted to improve our communication with our customers, but relevant information is not good when it's not on time. That why time is a very

important topic of discussion. There is nothing as bad as informing your customer that the shipment is too late, when the customer has already noticed. So real data on time.

You mentioned Transporion, what is this exactly?

From my point of view, I can tell you more about this matter. We looked at Transporion to optimise our warehouse and logistics. Also, for warehouse management in general, to take out activities that were done manually. Now operational employees get their information delivered automatically and where to get belongings in the warehouse. From the company point of view, we did things locally back in the days, which are now done centralized.

So, your company started with industry 4.0 already crossing different departments?

In the last two years I've seen a massive change in the company considering innovation. I'm talking about a big transformation by centralizing the company. This is only necessary if you use some of the technologies that are out there. You cannot stand still because this is the same as moving backwards. We keep improving. This is what I always have done, but also the company. By centralizing the departments, we noticed that we need more and more information. That's were industry 4.0 came in for us.

Would you see this as internal motivation or externally pressured towards industry 4.0?

Such a thing could be a combination. You get feedback from you supplier or customer about improvements which be externally pressured. On the other hand, for example Apple gave us smartphones where didn't even know we would need it. So internal motivation also could help us from that point of view to create solutions or customers did not think about. You want to keep investing and developing.

If you would compare yourself to competitors in the market, would you think you are one of the leading firms when it comes to maturity in industry 4.0?

In some respects, we are a little behind and on the other hand I think we are far up. You can always improve. So, for example we are not stealing ideas, but you need to benchmark as well. Ideas from other can also help us further along in the business. On the other hand, you should not look too much at competitors and concentrate on your own vision and believe in this.

Would you consider your company being a user, a provider or both for industry 4.0?

We have so many connections with customers, suppliers, people from our network. While sharing all data sure we also a role as provider.

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

As being said, as a company we were looking at possibilities of how we can present ourselves in the market. What can we offer? Therefore, we investigated platforms that could communicate with our internal systems and could help us collaborate with suppliers or logistic service providers. For us, everything we do is for creating an amazing customer experience. The drive of the business is to centralize, to improve the customer service. And ultimately, we want to do this with as less as possible resources.

Would cost reduction be a driver for you?

Controlling your overhead is important to all businesses. In the past and in the future. But in the end, in this context this would be less important than improving our service level. For example, in my opinion there is no need to reduce costs when service level goes down too. Service level always must go up. When you don't do this, your market share will be lost.

Second, these questions are based on a paper of Palmer et al. (2012)

- ***Do you recognize yourself in one of these drivers?***

As a company you always want to be ahead of the competition. With the industry 4.0 we think we can improve ourselves to be ahead. So sure, this is a driver. Regulation is not a noticeable driver for doing so at the moment. We do have a collaboration with Coke industries that take care of ethics and compliance. When talking about reducing CO2 and sustainability, this is a popular topic. It's always something you keep in mind. When considering industry 4.0 we are looking at ways to optimise our transport. Reloading transport when it arrives at the location is very important. This could lead to less dry kilometres, which will lead to a reduced CO2 from our transport.

- ***Could you rate all these drivers from 1 till 10 on their importance?***
- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Cost reduction 7 - 7

Demanding customers 10 - 10

Service level/ future 10 - 10

Increased differentiation 8 - 8

Increased competition 8 - 8

Increased regulation 1 - 1

Reduce CO2 8 - 8

Sustainability 8 - 8

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

For every company you are working with, you need to consider the long term. If they think it's about implementing and done, then it's not what we are looking for. For example, with transporion we knew there was a solid base, but after the implementation they needed to adjust to us specifically. Therefore, a company must by flexible and experienced in knowing what to do and giving the right amount of service. So long term goals and flexibility or very important.

Do you think only bigger companies can meet those requirements or also small companies?

Big is not always best. I would never move away from small companies, but they need to understand the way we are working. We are expanding to Russia and probably later to America and Asia. The company we are possibly be collaborating with should be able to keep up regarding the scalability. So, based on the scope of the project we would determine if a small company could be a potential collaboration partner.

The following questions are based on the partner selection elements.

- ***Do you recognise yourself in one of these elements?***

As being said you must have the same vision. This could be a fundamental fit and compatible goals. Does the possible partner want to improve, or do they think about the short term only? If you are looking at the implementation of a platform you need to have trust in the partners working with it. If there is no possibility to breach data.

Now, as we are already implementing a platform and are working with industry 4.0, we are looking for companies that do have the technological ability and experience. Never say never, but we do look for companies that have a concrete concept of proof. Again, this also depend on the scope of the project and where you want it to implement for. But if you have not actually proven something, there is no real need to collaborate.

Is this also because you think your company is already mature in industry 4.0?

Knowing how quick I need it, the time scalability, a company that is not ready could hold a possible collaboration on this matter so that to us is a reason. So therefore, not only market knowledge but also technological experience is very important when considering possible partners. Also, financial strength of the company and experience in the market are very important preferences.

There needs to be a certain level of experience. Looking back at transporion they needed to have some prove of a working platform in the transport business, before we would be a potential collaboration partner.

Would it be a problem if transporion already worked with competitors on this matter?

If the company only works within the glass industry and not in other industries considering transport, you are narrowing yourself for expanding knowledge. So, for me that is not a good sign. However, it could be important that there is already experience in our business. From a platform point of view there is also another issue. Because if they work for a competitor, they can see how they handle things. The same go for us too. So, with that they could learn from this as a platform. Therefore, we rather have someone outside of our own industry but with experience in transport.

- ***Could you rate these elements on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future***

Trust 9 - 9

Familiarity 5 - 5

Fundamental fit 10 - 10

Information exchange 9 - 9

Openness 9 - 9

Compatible goals 10 – 10

Commensurate levels of risk 5 - 5

Key people 8 - 8

Financial strength 8 - 8

Business case 8 - 8

Intra-organisational support 9 - 9

Complementary skills 9 - 9

ICT integration 9 - 9

Technological ability 10 - 10

Market knowledge 10 - 10

Size 7 - 7

Product characteristics -

Process -

Service level -

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

Again, when you start a project for implementing a TMS and knowing the start day and schedule, you will find out about things you did you consider at the start. So, there is people factor, when things can be implemented. And if we go through different regions, we have different specific adjustment which need to be taken care of.

So, if you think about barriers, people are the main barrier?

Every region has its own specific requirements. It's important that the platform is set up for those specific regions too. If you implement it at the first one, this needs to be finished before moving to the second.

Is the platform taking steps or is something holding it at the moment?

The platform is a little slowed down since the implementation. From a business point of view this is not a real big deal. With every step we want to improve our customer service, so why rush it? We want to make sure that everything is implemented in a correct way. Maybe it will be a little later than expected but at least it's done properly.

Do you think you are on track considering the trend industry 4.0?

If we would compare it to our own strategy plan from two years ago, we are pretty on time. It's realistic compared to where we want to be at this moment.

Or in case of no experience: What do you think are the barriers that will arise?

Not applicable.

The following questions are based on the barriers found beneath

- ***Do you recognise yourself in one of these barriers?***

Again, getting people on board is something that will be a barrier when implementing ideas based on industry 4.0. This something we noticed a lot in the previous two years where more and more systems are connected through different workstreams. There is a clear topic from the board ever since, to keep improving and in 2019 the goals are also to embed recent technologies into business.

Technological knowledge is a very complex one. Because sure this can be a barrier, you don't know what you don't know. Therefore, it's so important to reach outside company borders to other business within your network, to look for ways to improve transportation. So, knowledge is a key barrier for the future.

Could you rate these barriers on a scale from 1 till 10 on their importance?

- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?***

Bad information 1 - 1

Lack of culture 4 - 4

No aligning business strategy 1 - 1

Missing key people / leaders' mindset 7 - 7

Bounded rationality 8 - 8

Technological impediments 6 - 6

Lack of scalability 6 - 6

Too low level of automation 1 - 1

Too much financial effort 1 - 1

High switching costs 1 - 1

No solid business case 1 - 1

Do you think there is something missing when looking at the context these questions are asked, namely mapping the attitude of companies towards industry 4.0 and collaborations?

I think you covered everything. Some of these things are my knowledge and some are also difficult. I hope I covered what you expected from the interview.

Interview 5

Name: Participant E	**Date: 09-05-2019 Length: 53:55**
Gender: Male	**Language: Dutch**
Function: Central logistic manager	**Source of Contact: Emons**
Industry: Glass industry	**Type of interview: Face-to-face**

Collaborative experience

Do you have any experience in collaborations based on industry 4.0 settings?

- ***If yes, can you tell us more about it?***

The word industry 4.0 is kind of new to me. I did not investigate it that much. However, I am known with some of the facets rising from industry 4.0 after reading about the trend. We are already working with a long time with these ideas not knowing it was called this way. I notice that a lot of things are split up in boxes. For example, this is automatization. Or this is information that we are sharing with our customers or suppliers and we are trying to connect this with their information. The thing is that we are doing this with small projects and not with a red line through the whole company. That's where I know it from.

If you think about industry 4.0, what is your vision on this?

I think that industry 4.0 is rising with a rapid pace. The companies need to be ready and you must get the feeling that there is a certain base of trust for exchanging data. That's where people see problems. The last 2/3 years we see that people are digitalising more and more and urging for more information. With this information they want to improve their processes. First, I think of doing this internally and afterwards going outside company borders.

How far do you think you are internally based on industry 4.0?

On a scale from 1 till 10 I would give us a 5 or 6. I think they are plenty of possibilities that we did not found out about yet. You must have trust in the idea and that it can be exploited in a correct way. This goes for the internal departments, external environment but also shareholders.

This rating of 5 till 6. Is this holding or are there taking steps to get higher on this?

Now I think that at the moment we are taking quite some steps to improve. The previous years have not been that good for the company financially, but we can leave that part of history behind us and focus on

the future now. The focus back then was on making profit and keeping our customers happy. Nobody investigated digitalisation. At this moment the focus can be on those things again as we are financially stable. We have the energy now and the possibilities to pick up on those things in a rapid pace.

Previously you mentioned that customers are asking for more information, is this something you are noticing a lot?

Slowly this is starting. Customers are asking us for information about forecasting. With this information you gave them the possibility to optimise their processes.

Okay. So, would you say that the external environment pushes you to develop with these trends in mind, or is it also internal motivation?

Sure, we see that outside our company borders a lot of things are going on lately. But from internal motivation too. E-CMR is a hot topic. We know that transfollow is working on this. We tried this a couple of years back, but then the business was not ready yet. Now we picked it up again as I saw that some bigger companies have this operational already. At this point you know that the small impediments are out of the software and is ready to implement. We use Transfollow to digitalise our shipping documents for example. With all this information digitalized we can inform our customer with clear information and create more transparency in the supply chain.

From the outside we notice that customers start asking for information about precise delivery time etc. By proactively sending information to our customers through track and trace and reporting systems we hope to fulfil that need. This is quite unlike in our market as I see it as a very conservative market. For example, we still have some customers from Germany that work with a fax machine.

So, do you think it's just a trend or a truly need?

No, I think it's a truly need. Because companies are internally optimising their business, they eventually need information from other companies to establish this. That's why they want this certainty about information. There you see that the better organised firms come with this question earlier than the companies that are not organised well. There are also companies that still call us to order. For us this makes it so complex to estimate the need in what our customers want and what not. Because these small companies will not be in the need for this information, I think.

How far are you in collaborating or developing in industry 4.0 settings?

With this solution of Transfollow I think we are further than some competitors. This is what I see as downstream. When we are talking about upstream, I think we are not as far as some bigger competitors. They have been earning some more money in the last 10 years, so they are walking in front of this.

Drivers of collaboration

What are your main drivers for collaborating by industry 4.0 settings?

If we focus on for example our project with Transfollow. One of the main drivers is absolutely all the paperwork that was there. It was annoying and time wasting. You can never express it perfectly in costs, but I can imagine would could have saved a lot more when doing this earlier. On the other hand, I would

also say, because of customers complaining a lot about shipments being too late, to improve the service. We want to inform customers beforehand to make sure less complaint come afterwards. So, this is partly improving our service to meet demanding customers. Also making our business lean. Not that much communication lines. Just one clear line.

Second, these questions are based on a paper of Palmer et al. (2012)

- ***Do you recognize yourself in one of these drivers?***

As we spoke about before. I think increasing our service level is even important as reducing costs. Regulation can be seen more as barrier for example in Germany. Here we also want to work with the transfollow project, but this is not possible yet due to regulation. CO2 is something we are dealing with a lot in the company, but not on this topic. This is not where I am thinking about when considering industry 4.0. When I think about industry 4.0, I think about data sharing and supply chain collaboration. in recent history we did work on a collaboration project to think about electric cars etc., but this is too far away, I think. I believe in the future this will be different, but not now. I think the company I work far is not the company to walk in front on this topic.

Increased competition and differentiation are something we always consider because the bigger companies are a little bit ahead of us.

- ***Could you rate all these drivers from 1 till 10 on their importance?***
- ***One a scale from 1 till 10, would you think this is becoming less important, even important or more important in the future?***

Cost reduction 8 - 8

Demanding customers 10 - 10

Service level/ future 10 - 10

Increased differentiation 5 - 5

Increased competition 5 - 5

Increased regulation 5 - 5

Reduce CO2 1 - 1

Sustainability 1 - 1

Partner preferences

What are your preferences when searching for a partner to collaborate by industry 4.0 settings?

I would look at the wideness. Wideness as: how wide are they establishing themselves. Is it just a simple solution or is it more than that? For example, I had contact with a firm that did a thing with track and trace, but this company was focussed on one niche market only. For us it is important that it is also possible for our market. Can it connect to our systems we are working with?

Do you think size of a company plays a role in this?

Yes, I think so. They probably have more experience in the business.

The following questions are based on the partner selection elements.

- ***Do you recognise yourself in one of these elements?***

Automatically I look at trust. Of course, this is important, especially considering data. When I look at strategic fit, this is what I meant with their experience. Can they do it only in the Netherlands, or can they do it on a larger scale? What I think is important is if they already have some business cases on their name. With that you show that you have something. And, which names are in those business cases. If they have a big name, then you know: okay these boys are working professionally and know what they are doing. The small impediments are out and that's a point where we will dare to step in.

And if we look at technological fit?

Of course, this is important too when considering experience. Sure, they must have a technological fit, otherwise they cannot deliver. When we started with Transfollow for example, we could see that their business just started. A lot of small impediments. At the point when I saw it, I thought no this is not the correct way. At that time, we said, okay we will wait until its better. At the same time, we investigated other companies that could do it at that moment. They are not so many, maybe transporion. But now we see that transfollow bettered their business. IT technological have chosen for simple solutions, by platforming. Like gathering all the data and link it to the correct destinations. For us this is also important because we did not want to change or own systems to make sure this would work.

Are there also elements that do not play an important role to you?

For example, familiarity. What is familiarity? If the company does something good, I would probably know about, otherwise it would not be as good. It does not have to be a known partner to us, but if it's going to be a possible partner, probably I will know about it. Take for example app builders. We build an app for making QR codes on our glass holders. You can hire very professional firms for this, but we encountered a small company via a third party and there was a click from the start. They had a simple solution and quick access to it.

Why is this possible when considering your previous comment about size being a preference?

Because of the scalability and the subject. We previously talked about E-CMR which is a bigger project. There are a lot of legal matters that need to be handled in that case so that's why a bigger firm could help with their experience. You are legally obligatory to have a CMR and a small amount of companies are qualified to offer this.

Is operational fit important apart of size of company?

When we talk about support this is also important but a tricky argument. While bigger firms have a bigger support desk, you'll probably see that support takes more time and is more general. I would almost say that support from smaller firms is better because they have more time for you.

- ***Could you rate these elements on a scale from 1 till 10 on their importance?***
- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future***

Trust 10 - 10

Familiarity 5 - 5

Fundamental fit 8 - 8

Information exchange 9 - 10

Openness 10 - 10

Compatible goals 8 - 8

Commensurate levels of risk 5 - 5

Key people 8 - 8

Financial strength 6 - 6

Business case 10 - 10

Intra-organisational support 6 - 6

Complementary skills 10 - 10

ICT integration 10 - 10

Technological ability 10 - 10

Market knowledge 9 - 10

Size 8 - 8

Product characteristics 8 - 8

Process 3 - 3

Service level 7 - 7

Perceived barriers

What barriers came forward while collaborating in industry 4.0 settings?

Yes, I think the acceptance of these processes. It's a conservative business. With implementing this application for example, location needs to be shared. But not everyone wants this. This makes it hard. There are scared with what we will do with this data. Especially with third parties this is noticeable. With

our own suppliers not as much, as this will already be part of the negotiations for collaboration. That's where the challenge is. To build a solid transparent system, so that people have trust and think they can get something out of it too. In the media you hear a lot about data breaches, so that's what scares people.

Do you think this attitude differs per region?

The Netherlands are ahead of other countries we work in. We notice that Germany is more conservative with sharing data etc. Belgium you just never know. In our business it's also, as I speak from a middle-sized company, that we don't want to show the big companies what we are doing. We build a small wall in which they can see until a certain height. We show some things and if they ask for more, we drop it. That's something that's there since the start. For example, when we look at the glass holders. Right now, everyone is using the holders of everyone, but nowadays everyone starts working with tags on them. This means that the big companies can see exactly where these holders are going. In other words, they know exactly what we are doing and that something we will not accept.

The following questions are based on the barriers found beneath

- ***Do you recognise yourself in one of these barriers?***

People are the most important barrier. As being discussed this can be seen as trust and bounded rationality. People fear the consequences and need to feel secure about something before working with it.

When we look at data we are not interested in a lot of information. Speed, tire pressure, the humidity are all things that are not so relevant. I want to know about where the truck is when is wanting to know and how long it will take him to arrive at the destination.

Do you think you are a user or a supplier of industry 4.0?

Depends on the sensitivity of the data. There were some customers that asked us about certain data, which is no problem, but we will give it dosed.

So, would you send stock information to other bigger competitors so they can fill in a possible shortage?

No, we would not. We work with general forecasts. They are made based on our own estimations. You agree upon a certain amount of shipments and this will be good for 80 till 90%. For the remaining shipments we are creatively enough to think about a solution.

Could you rate these barriers on a scale from 1 till 10 on their importance?

- ***One a scale from 1 till 5, would you think this is becoming less important, even important or more important in the future?***

Bad information 5 - 5

Lack of trust 10 - 10

No aligning business strategy 1 - 1

Missing key people / leaders' mindset 6 - 6

Bounded rationality 10 - 10

Technological impediments 5 - 5

Lack of scalability 7 - 7

Too low level of automation 5 - 5

Too much financial effort 1 - 1

High switching costs 1 - 1

No solid business case 5 - 5

Do you think there is something missing when looking at the context these questions are asked, namely mapping the attitude of companies towards industry 4.0 and collaborations?

Yes, maybe legal aspects. There are some legal and ethical considerations in this story. How far can you go with data for example? Which risks will arise? This can be seen as unknown ground.

APPENDIX 6: FOCUS GROUP NOTES

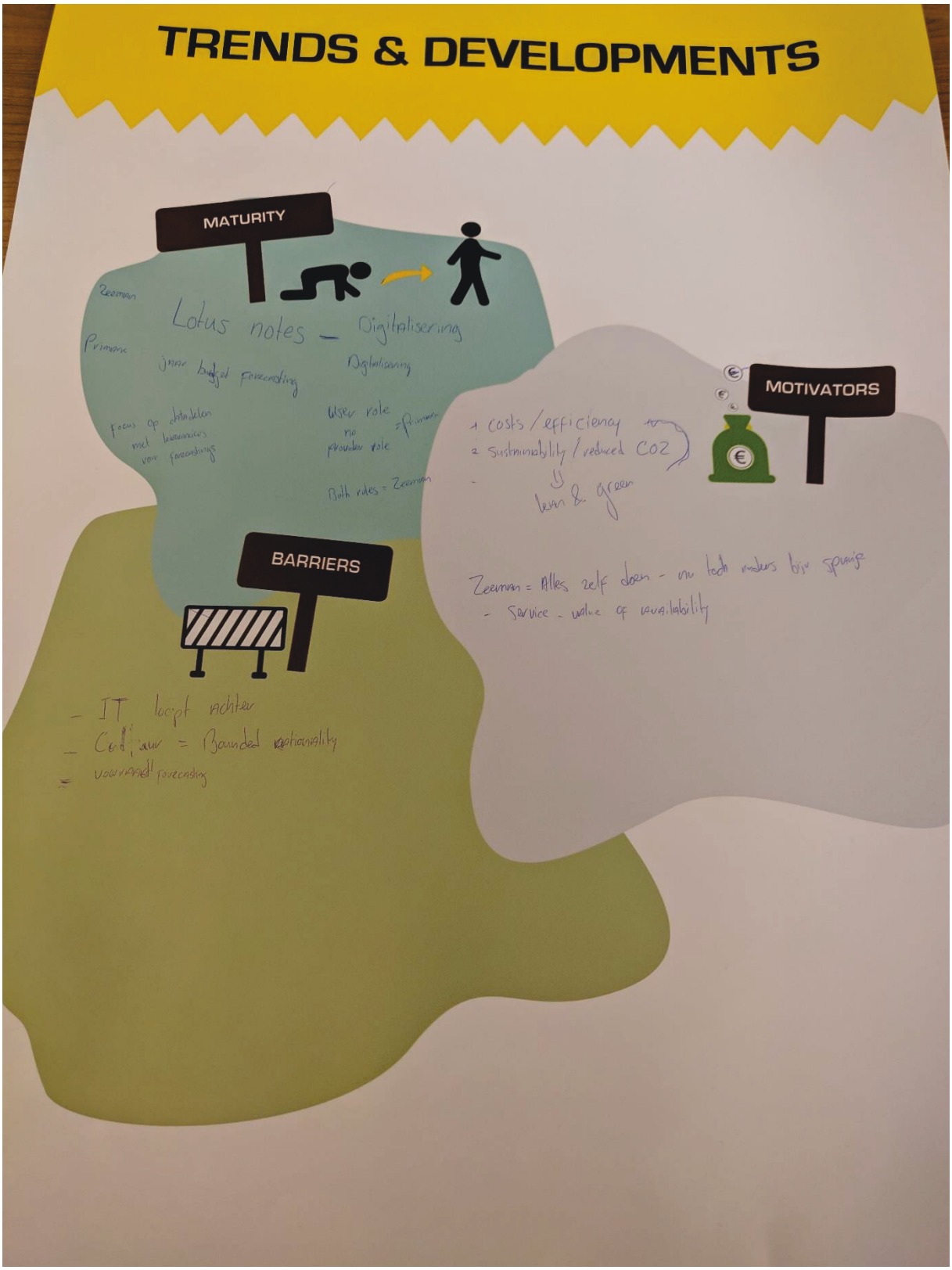


Figure 16: Focus group notes

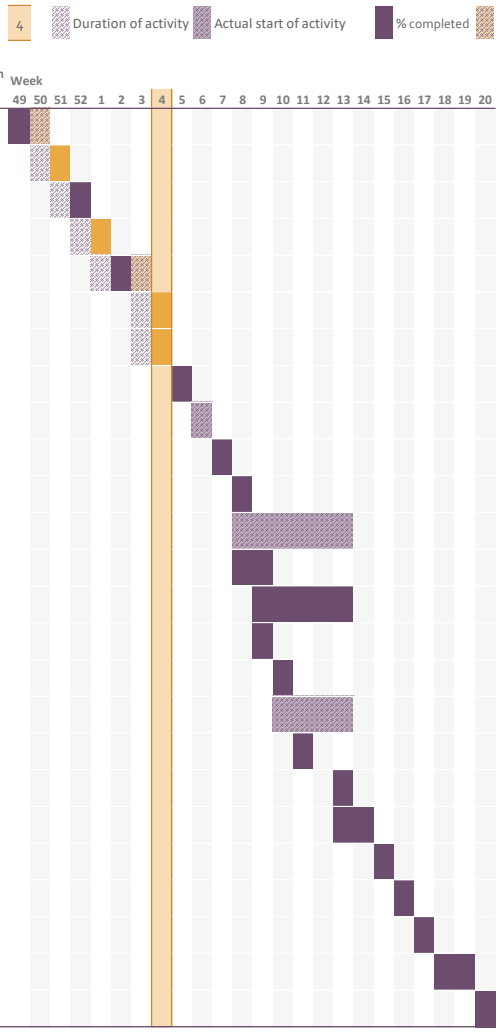
APPENDIX 7: PLANNING

At last the planning of the research will be described. In an overall planning of the whole research is shown. This planning is carefully made based on estimations and considering contingencies. The advantage of this project planner is that it gives the possibility to correct the estimated planning with the actual planning. This is seen in the first couple of activities that have been executed in the last weeks. Here a difference occurs between the planned and the actual start and duration of an activity. A full explanation of the planning will be given here.

The project planner starts with week 49 of 2018. Here the project started at Emons. During the last few weeks until week 4 (2019), the activities were focussed on creating and forming this research proposal. Next week, week 5, the research itself starts. The estimation is that it will take 15 weeks to finish the research. Of course, there is a possibility that it takes longer, so there is a time extension period of five weeks (since thesis part 2 should be finished within 20 weeks). Every week the project planner will be updated with the actual start and duration of an activity, so that the maximum time and deadlines will be met.

A vacation period has been taking into account during week 6. In this period there is no time for project activities. Furthermore, there are two contingencies included in the planning. These contingencies are focussed on the response time of the questionnaire and interviews. During these periods, several other activities have been scheduled. In this way, the research does not have to wait. One of these activities is data collection and analysis. Because it is an iterative process, the data analysis starts at the same time as the collection. There is a deadline set on the collection of all the data. After this deadline the final analysis Can be done, and findings can be presented. This leaves enough room build upon the findings with proper conclusions and discussion topics. At last there is time for finalizing the master thesis.

Project planner



Activity	Start of activity	Duration of the activity	Actual start of activity	Actual duration
Writing situation and complication	49	1	49	2
Writing research question	50	1	51	1
Writing theoretical framework	51	2	52	2
Writing implications	52	1	1	1
Writing research design	1	2	2	2
Writing planning	3	1	4	1
Deadline research proposal	3	1	4	1
Answering RQ1	5	1	5	1
Vacation	6	1	6	1
Plan and prepare open questionnaires	7	1	7	1
Send open questionnaires	8	1	8	1
Contigency 1: response time questionairre	8	6	8	6
Plan and prepare interviews	8	2	8	2
Collecting and analyzing data	9	5	9	5
Send reminder questionnaire	9	1	9	1
Send interview inventation	10	1	10	1
Contigency 2: respons time interviews	10	4	10	4
Send reminder interview	11	1	11	1
Deadline for receiving all the data	13	1	13	1
Analyzing data further	13	2	13	2
Present findings	15	1	15	1
Forming results into a tool	16	1	16	1
Write conclusions/further research	17	1	17	1
Finish writing the thesis	18	2	18	2
Deadline delivering final thesis	20	1	20	1