# Exploring the impact of suppliers and customers on the Industry 4.0 implementation process of SMEs using the Smart Industry Maturity Scan (SIMS)

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**ABSTRACT,**

*This study investigates the impact of suppliers and customers on the Industry 4.0 implementation process of small and medium-sized enterprises (SMEs) using the Smart Industry Maturity Scan (SIMS). The focus of this study is on interferences regarding the suppliers and customers on the process and how these interferences can be avoided or minimized by using strategies. The fourth industrial revolution is currently changing the markets of small and medium-sized enterprises drastically. The aspects of Industry 4.0, for example, the digitization of production or artificial intelligence and big data are drivers for a complete industry change. Thus, it is important for small and medium-sized enterprises to implement Industry 4.0 to stay competitive in their operating market. At this point, it is important to know to what extent and in which way the suppliers and customers of small and medium-sized enterprises interfere the implementation process. By applying the Smart-Industry-Maturity Scan to two German SMEs, a status-quo regarding their level of integration of Industry 4.0 was drawn. Both companies scored low concerning their Industry 4.0 maturity so a Mini Group workshop was carried out in which the companies responded to questions concerning possible interferences of their suppliers and customers and how the companies could avoid or minimize them by using which kind of strategy. Furthermore, based on the results from the scan as well as from the Mini Group workshop and from literature, recommendations are displayed to help other companies recognizing interferences of their suppliers and customers on the integration process of Industry 4.0 and how to avoid or minimize them in the future. The results of this research can be helpful for all parties in the value chain, SMEs, their suppliers as well as their customers since implementing Industry 4.0 clearly benefits them all.*

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# 1.    INTRODUCTION

## 1.1 TOPIC RELEVANCE

The future of small and medium-sized enterprises (SMEs) is currently influenced by the upcoming fourth industrial revolution. Terms like "Smart Industry" or the "Internet of Things (IoT)" are characteristics of Industry 4.0, which is an emerging new view on industry including aspects like artificial intelligence, big data, digitization, communication and even more. In general, the digitization of production, automated systems as well as linking manufacturing sites in a comprehensive supply chain are the drivers for a complete industry change (Almada-Lobo, 2016; Schlechtendahl, Keinert, Kretschmer, Lechler, & Verl, 2015). The term Industry 4.0 was first introduced in 2011 as the "Industrie 4.0" to force the German competitiveness in the manufacturing industry and was included in the "High-Tech Strategy" for 2020 by the German federal government. While facing a lot of potentials of Industry 4.0 for SMEs like Smart Logistics, for example, the automated identification and traceability of products or a whole interrelated manufacturing system through IoT, there are also some limitations and integration barriers for SME's (Matt et al., 2020). The overall success of SMEs is related to their capacity on dealing with innovation (Matt et al., 2020). Especially the organizational culture can have a high impact on the implementation of innovation in SMEs, for example, the lack of support from customers and suppliers is directly related to the degree of innovation of a SME (Hewitt-Dundas, 2006). The lack of a pro-active response to innovation, for example, a reconfiguration of resources to make them probable for Industry 4.0 implementations as well as a lack of external partners are forming external and internal barriers for the implementation of Industry 4.0 (Hewitt-Dundas, 2006). Currently, most theoretical papers pay attention to the internal challenges and potentials of Industry 4.0. However, the process of integration across company boundaries also raises a lot of challenges (Müller, Veile, & Voigt, 2018). Accordingly, questions for requirements that need to be met when integrating suppliers and customers or the need for strategy to integrate customers and suppliers arise. Since the integration of customers and suppliers into the implementation process of Industry 4.0 regarding SMEs creates value and a sustainable competitive advantage, research must be undertaken to find out the extent to which external suppliers and customers of SMEs have an impact on the implementation process of Industry 4.0 and all its aspects (Müller, Veile, & Voigt, 2018); (Deloitte., 2016).

## 1.2 RESEARCH OBJECTIVE

This thesis is pointing out the general aspects of Industry 4.0 for small and medium-sized enterprises (SMEs) and the degree of implementation of Industry 4.0 concerning SMEs. Furthermore, the research aims at the influence and impact of SME's suppliers as well as customers on the integration process of Industry 4.0 and how negative influences or interferences on this process can be tackled or avoided by which kind of strategy. With the cooperation of two German companies which reported difficulties for the implementation process according to their suppliers and customers in advance, the degree of restriction by suppliers and customers for the implementation of Industry 4.0 will be examined. The first step is looking at the respective status quo of the extent to which Industry 4.0 is embedded in the companies and how the unuse of the current potential is influenced by the company's supplier and customer.

## 1.3 RESEARCH QUESTION

Based on the research objective, following research question was formulated:

*"To what extent do customers and suppliers impair the integration of Industry 4.0 in relation to small and medium-sized enterprises and how can these impairments be reduced or prevented?"*

Following sub-questions will be answered in this research:

- What are the key elements of Industry 4.0 for SMEs and how can they be of value for SMEs?
- To what extent are suppliers and customers integrated into the implementation process of Industry 4.0 by SMEs?
- What kind of factors, according to SME's suppliers, interfere with the implementation process of Industry 4.0?
- What kind of factors, according to SME's customers, interfere with the implementation process of Industry 4.0?
- What kind of strategies for a successful implementation of Industry 4.0 concerning the commitment of suppliers and customers are identified in the literature?
- How can these strategies be applied in practice?

# 2.    THEORETICAL FRAMEWORK

To examine the extent of the integration of Industry 4.0 of small and medium-sized companies as well as the effects of suppliers and customers on this integration, the core concepts of Industry 4.0 are examined. This means that the evolution of the term "Industry 4.0" will be explained as well as the technological innovations and benefits coming along with the fourth industrial revolution. Furthermore, the aspects that lead to restrictions in the implementation process and are caused by suppliers and customers of SMEs are displayed. Additionally, strategies for a successful supplier and customer involvement are pointed out. Since the level of Smart Industry maturity can be searched out by using Smart Industry Scans, a Smart Industry Maturity Scan that is used for the examination of the degree of implementation of Industry 4.0 concerning SMEs is explained and then used for the data collection of this research. The scan will help to identify areas in which the examined companies have unused potential regarding the implementation of Industry 4.0. Then, it is examined to what extent this disuse of the potential is influenced by the company's suppliers and customers. Finally, strategies for avoiding a negative influence are represented.

## 2.1 THE MAIN ASPECTS OF INDUSTRY 4.0 FOR SMEs

In general, the term Industry 4.0 describes the ongoing fourth industrial revolution that influences manufacturing companies on our planet (Matt et al., 2020). Industrial revolutions are paradigm shifts mostly forced by technical innovations (Müller, Veile, & Voigt, 2018). Industry 4.0 is mainly characterized by a digital interconnection and virtualization of processes related to industrial value creation, for example, Industry 4.0 offers an intelligent and interconnected platform for people, plants, machines, logistics and products belonging to SMEs (Müller, Veile, & Voigt, 2018). Basically, Industry 4.0 can be described as the intelligent networking of operational processes and machines for industry by using communication and information technology (Federal Ministry for Economic Affairs and Energy et al., 2013). It offers a more flexible production process that is digitally networked so that machine load can be better coordinated, thus, productivity and efficiency in factories can be enhanced (Federal Ministry for Economic Affairs and Energy et al., 2013). Furthermore, smart products can be used for the manufacturer to enhance the overall value of products being sold. For example, mobile phones can send information to their manufacturing company about the current performance of the

phone. This information can be used for further improvements of the product (Federal Ministry for Economic Affairs and Energy et al., 2013). For Industry 4.0, the core technology is not the computer itself anymore, it is the internet which leads us to the term of the Internet of Things (IoT). The IoT is a global information system including a massive number of technological devices that can be controlled and identified based on normed communication protocols and enables these devices to communicate within a smart environment, so autonomously interacting with each other (Zhang & Chen, 2019). Another important factor in Industry 4.0 are Cyber Physical Systems (CPS). CPS are systems that enable a connection of real-world physical operations, for example, designing a car by hand with computing and communication infrastructures that are digital or even not physical (Jazdi, 2014). The focus of CPS is to enable a networking system between technological devices, for example, smart homes can be greatly explained by a CPS (Jazdi, 2014). As the alarm in the morning makes a person getting up, the coffee machine automatically begins to brew coffee, the smart fridge in the kitchen shows all appointments for the day and the TV automatically turns on the daily news. Such a system can also be transferred to SMEs. For example, if an order for an online store was placed, the stock will be automatically updated. If there is no item left after removing the last one from the stock, a new load of items will be automatically purchased, and the management will be automatically informed that there was a high demand for the product. Furthermore, Cloud Computing is another crucial aspect of Industry 4.0. A cloud enables a person to have access to networks, servers, storage, applications, and other services, regardless of their current time and geographical location on demand (Armbrust et al., 2010). Moreover, the rising trend for digital servitization is a product of the fourth industrial revolution. It can be formally described as the provision of digital services that are embedded in the product a company is selling (Kamalaldin et al., 2020). Establishing digital servitization creates new revenue streams by providing closer collaboration between a company and its customers (Kamalaldin et al., 2020). The most important driver for all the mentioned technologies is called Big Data. Big Data is a term for structured as well as unstructured data that is used and generated by smart (IoT) devices, industrial equipment, videos, or social media (SAS, 2018). Characteristics of Big Data are its high volume, so there are storage solutions needed like data lakes or clouds, its velocity, so that data streams that are related to the business have a higher speed and must be handled in real-time, and the variety of data since it comes in all types of formats (SAS, 2018). For conclusion, the implementation of Industry 4.0 can have high benefits for SMEs (Matt et al., 2020). Nevertheless, the implementation of Industry 4.0 is also affected by the suppliers and customers of SMEs and those restrictions must be faced and tackled (Müller, Veile, & Voigt, 2018). Furthermore, the extent to which suppliers are integrated into the implementation process of Industry 4.0 has an impact on the overall usability of Industry 4.0 regarding the implementing company (Siepmann, 2016).

## 2.2 INTERFERENCES OF CUSTOMERS AND SUPPLIERS ON THE INDUSTRY 4.0 IMPLEMENTATION PROCESS OF SMEs
Networking across the own company boundaries of an SME is crucial for a successful implementation of Industry 4.0 (Müller, Veile, & Voigt, 2018). A first challenge to mention for the integration of Industry 4.0 is the openness and willingness to cooperate on both sides, so the supplier as well as the company (Müller, Veile, & Voigt, 2018; Kiel et al., 2017).

Furthermore, the suppliers need an appropriate infrastructure to support Industry 4.0 related aspects as well as the needed knowledge (Müller, Veile, & Voigt, 2018), for example, for innovative communication systems. Next, different Enterprise-Resource-Planning (ERP) systems can negatively influence the integration since Industry 4.0 tries to enable a global network of systems that autonomously work together (Müller, Veile, & Voigt, 2018). A lack of financial resources as well as an unskilled workforce can also impede the integration of suppliers into the implementation process of Industry 4.0 (Müller, Veile, & Voigt, 2018). Müller, Veile and Voigt (2018) also mentioned in their research, that there are a lot of suppliers that do not pay attention to the urgency of the Industry 4.0 implementation and therefore do not have a pro-active attitude towards the implementation process. Furthermore, they are describing that most suppliers are facing uncertainty when it comes to data security and protection and thus are unwilling to adapt the aspects of Industry 4.0. As organizational data is currently treated as a trade secret, suppliers mostly do not have the intention to disclose their data which is needed for the implementation of Industry 4.0 (Müller, Veile, & Voigt, 2018). Implementing Industry 4.0 also needs good data management (Hood et al., 2016). Companies must be able to effectively use new customer data as well as old, stored data (Hood et al., 2016). That means that customers must be open for a continuous storage of their data according to their interactions with the company but also be opened to share them to feed for example CPS. Other issues that arise when looking at customers is a lack of visibility into the usage by customers concerning the sold product (Hood et al., 2016). As earlier mentioned, smart products can enhance the performance and maintenance of products, so knowing the actual purpose of customers using the product could enhance its future performance. Furthermore, the creation of digital customer connections is needed and new innovational ways of doing so need to be implemented (Deloitte., 2016). According to this, Kamalaldin et al. found out that there are interferences of customers concerning digital servitization (Kamalaldin et al., 2020). Since the relationship of a company and its customers is the most important aspect when it comes to digital servitization, a company should be able to focus on four important relational aspects regarding digital servitization; relation-specific digital assets, digitally enabled knowledge-sharing routines, complementary digitalization capabilities and partnership governance (Kamalaldin et al., 2020). However, it could be that a customer is unable to change the relationship to the company since the customer could be unable to meet the relational requirements, for example, the customer is unable to meet the required speed of innovation in digital servitization (Kamalaldin et al., 2020).

## 2.3 STRATEGIES TO AVOID INTERFERENCES OF SME's SUPPLIERS AND CUSTOMERS ON THE IMPLEMENTATION PROCESS OF INDUSTRY 4.0
For suppliers, the very first strategic aspect that needs to be mentioned is the understanding and communication of standards coming along with the integration of Industry 4.0. Making the requirements that suppliers need to fulfill understandable is important (Müller, Veile, & Voigt, 2018). Furthermore, the establishment of platforms can help integrate suppliers into the implementation process of Industry 4.0 (Müller, Veile, & Voigt, 2018). Making information available for all partners that are included in the value chain can be highly beneficial and communication, honesty and transparency can help to successfully implement the supplier (Müller, Veile, & Voigt, 2018). As the security lack that could come along with

the integration of Industry 4.0 was already mentioned before, contractual security is crucial since suppliers generally aim at long-term contracts and investments are often made to benefit in the long run (Müller, Veile, & Voigt, 2018). So, to get the supplier investing into Industry 4.0 implementations and its required technology, the relationship should be based long-term from the beginning on (Müller, Veile, & Voigt, 2018). In addition, new business models where the suppliers are directly integrated can help to motivate their commitment towards using and implementing Industry 4.0 (Müller, Veile, & Voigt, 2018). Focusing on the integration of customers, building new platforms that combine marketing information and customer information to come up with new marketing processes as well as sales processes can be crucial (Deloitte., 2016). The Deloite. University Press (2016) also states that manufacturing firms' leaders should challenge themselves to find interferences that prevent digital first entrants to intermediate the company that is implementing Industry 4.0 or to think about how customer value can be created and evaluated according to the rising benefit in monetary terms by digital customer experiences (Deloitte., 2016). Since Kamalaldin et al. (2020) mentioned possible interferences of customers when it comes to digital servitization that could provide new revenue streams for the company, there are also strategies mentioned to overcome these hurdles. Their "relational transformation framework" greatly describes how the company and its customers should cooperate and interact with each other to avoid facing the mentioned interferences (Kamalaldin et al., 2020). Focusing on the possible interferences of customers on the implementation process of Industry 4.0 of SMEs again, which were the lack of willingness to let SMEs store data of customers that are needed for autonomous working systems, the lack of knowledge about the way on how products are actually used and the lack of digital customer connection, some companies have greatly overcome these interferences. For example, the car manufacturer Tesla Inc. which is one of the world's leading electric car manufacturers has embedded strategies to overcome the interferences very beneficially (Driving Digital Transformation at Tesla — The Future Factory®: Business Transformation Training, 2018). Tesla has created the so-called connected car which is able to unify the full driving experience of its customers (Driving Digital Transformation at Tesla — The Future Factory®: Business Transformation Training, 2018). Sensors that can help the driver, real-time software updates that can be directly installed by the driver, autopilots and significant computing power of data can all be seen as beneficial touchpoints to the customer and be of value for Tesla (Driving Digital Transformation at Tesla — The Future Factory®: Business Transformation Training, 2018). The systems mentioned above needs the willingness of customers to share data to feed this system. The intention of such a system is giving a clear picture of how customers are using the car to enhance its value to the customer and providing a lot of connection between customers, the car, and its producer. For example, the free software updates that are resulting from customer experiences that were shared are of value for the customer then. Furthermore, their digital marketing strategy helps users to make the buying decision and process easier by selling cars online and give customers the opportunity to communicate on social media and other platforms on the internet (Driving Digital Transformation at Tesla — The Future Factory®: Business Transformation Training, 2018).

If we focus on the possible interferences of suppliers on the implementation process of Industry 4.0 of SMEs which were the lack of openness to cooperate, a lack of needed infrastructure to support Industry 4.0, the need for the same ERP system to enable global networks, a lack of financial resources, no attention that is given to the urgency of Industry 4.0, uncertainty according to data protection as well as no intention to disclose data due to trade secrets, there are also companies who tackled these interferences in the past. For example, the healthcare company Johnson & Johnson GmbH. has redefined their entire supply chain (Johnson & Johnson, 2018). They are focusing on the implementation of a fully digitized supply chain, so the data concerning suppliers are needed to do that. They are calling it the end-to-end visibility that can make the supply chain more responsive, nimble as well as predictive (Johnson & Johnson, 2018). According to Johnson & Johnson, such digitized systems can help make supply more reliable and enhance its quality (Johnson & Johnson, 2018). All in all, the benefits for both sides of this relationship, so the company and its supplier seem to be greater than the drawbacks coming along. These benefits should be communicated so that both sides can see its potential and value to either the company or its supplier.

# 3.    METHODOLOGY
## 3.1 RESEARCH SETTING
The strategy to research the stated problems concerning the impact of suppliers and customers on the implementation process of Industry 4.0 for small and medium-sized enterprises is an in-depth case study. Using an in-depth case study helps to generate an in-depth, multi-faceted understanding of the mentioned issue in a real-life context (Crowe et al., 2011; Heale & Twycross, 2017). First, a literature review of what is known about the case is conducted which also benefits the development of the research question and its sub-questions (Heale & Twycross, 2017). To gather even more qualitative information, a focus group is set up with the researcher being non-directive, allowing the group to explore the issue from all different angles (Longhurst, 2003). In the focus group session, open conversation among the participants is allowed, commenting, or asking questions to further stimulate an in-depth discussion of the topic (Folch-Lyon & Trost, 1981). Furthermore, the "Smart Industry Maturity Scan" which was made available by the Dutch company "IXIA smart insights" will be used to analyze the maturity of two German companies according to their integration of Industry 4.0 on a quantitative level (IXIA smart insights, 2020). The scan displays the level of maturity of Industry 4.0 for the investigated companies and thus, it can give information about unused potential for these companies since a low score shows an opportunity to further improve in this field of Industry 4.0 (IXIA smart insights, 2020). This information can be used to identify barriers, so answering the question why the potentials are unused and to which extent suppliers and customers of the participating SMEs prevent or influence the usage of the potentials. Using both qualitative as well as quantitative techniques for gathering information can help to develop a holistic picture of the issue mentioned (Crowe et al., 2011). The two companies that are examined in this report are small and-medium sized companies located in the north-west of Germany. Company A is a B2B (business-to-business) as well as B2C (business-to-consumer) company selling medical consumables in the first place. Over time, the company expanded its product portfolio including company branded products. The products are sold through an own online shop but also through online retailers like Amazon or eBay. The company currently employs 13 people and generates annual sales of € 5 million. Company B is a B2B manufacturing company selling sealing systems and elastomer profiles for sewer construction, tunnel construction or other applications. The company employs between 25 and 50 people and generates annual sales of €10 to €25 million.

Having a mixture of data from a classical manufacturing company and an online company selling goods through the internet can help to avoid gaining an industry-affected view on SMEs and their level of maturity of Industry 4.0. For example, a company selling goods through the internet normally needs to be open for technological ways of working but a traditional manufacturing company does not necessarily need to integrate such technology to keep the business running.

### 3.2 RESEARCH DESIGN
The type of research that is undertaken refers to a cross-sectional case study. It helps to describe the case which belongs to the possible interferences of suppliers and customers on the Industry 4.0 implementation process of two German small and medium-sized companies with respect to the desired outcome (Levin,2006). However, the study is limited to the fact that it is carried out at one point in time, so causality is not given (Levin,2006). The "SIMS" that was made available by the company "IXIA smart insights" identifies unused potential for both companies according to their Industry 4.0 integration and a Focus Group will help to identify the impact of suppliers and customers of both firms on the implementation process of Industry 4.0 and especially how they impair the process.

### 3.3 DATA COLLECTION
#### 3.3.1 THE SIMS SCAN
The SIMS gives insights into the extent to which a company is able to operate in smart industrial environments (IXIA smart insights, 2020). The SIMS contains questions related to 7 core aspects of a company which are products and customer service, value chain, technology and IT-management, strategy and organization, customer interfaces, people, and organizational culture as well as the institutional awareness (IXIA smart insights, 2020). The SIMS provides a multidimensional insight into the status-quo of the company's Industry 4.0 implementation as well as aspects that need specific attention for further growth (IXIA smart insights, 2020). Therefore, the SIMS can be used to find unused potential which could lead to a benefit if it is used in the future. The questions of the SIMS are answered online by one of the company's representatives and the outcome will be displayed in the form of an online dashboard (IXIA smart insights, 2020). Moreover, the outcomes are displayed as simple 2D bar charts in this report to offer a good overview of the results of the SIMS since bar charts provide a useful method of comparing multiple variables (Freeman, 2021).

#### 3.3.2 FOCUS GROUP
The focus group interview will be limited in person in favor of the companies, since the effort of them should be kept as small as possible. Therefore, the method of a mini group is used which contains 4-6 participating people which is less than for a full focus group (Greenbaum, 1998). According to the outbreak of the Coronavirus on the 31st of December 2019, the risk of spreading the virus is minimized by using a virtual conference for the mini groups. Basically, the technique of a mini group will be combined with that of a telephone group where the group is conducted in a conference call environment and the participants as well as the researcher are all in different locations (Greenbaum, 1998). The participants of the mini groups are selected on the criteria that they have a direct or indirect relationship to the company's suppliers and customers to provide the highest-quality discussion on the impact of suppliers and customers on the implementation process of Industry 4.0 (Folch-Lyon & Trost, 1981). The discussion is led by a moderator that guides the discussion. The discussion is related to the unused potential of Industry 4.0 and the impact of

suppliers and customers on the implementation process, as investigated by the SIMS scan. The goal of the focus group is to determine the extent of the impact of suppliers and customers and the reason why and how they interfere the implementation process.

## 4. EMPIRICAL RESULTS
This chapter displays the results of the Smart-Industry-Maturity-Scan (SIMS) as well as the results of the mini-group discussion (Focus Group). The scores of the SIMS for both companies are displayed in a Table 1. To get a better overview of the scores, Figure 1 and Figure 2 display the scores as 2D-bar charts followed by a short summary of the corresponding average overall score for both companies. Since we are mostly interested in the interferences of customers and suppliers of both companies on the level of integration of Industry 4.0, we will analyze the scores in-depth to investigate where possibly interferences took place or where customers and suppliers could have had an impact on the score.

### 4.1 LEVEL OF MATURITY
Table 1: SIMS scan scores for both companies per aspect

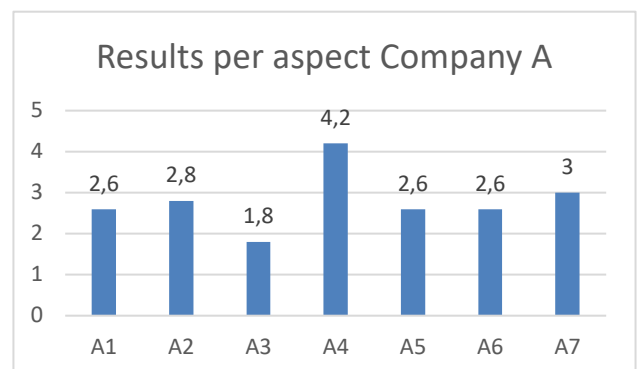| Aspects | Scores Company A | Scores Company B |
|---|---|---|
| Introduction Questions | 3,18 | 2,00 |
| A1: Strategy and organization | 2,60 | 2,20 |
| A2: People and Organizational culture | 2,80 | 2,00 |
| A3: Products and customer services | 1,80 | 1,40 |
| A4: Customer interfaces | 4,20 | 2,00 |
| A5: Value chain | 2,60 | 2,20 |
| A6: Technology and IT management | 2,60 | 1,80 |
| A7: Institutional awareness | 3,00 | 1,40 |
| Total average of all aspects | 2,85 | 1,88 |
| Total average of aspects excluding introduction questions | 2,80 | 1,90 |



**Figure 1. Results per aspect for Company A on a 5-point scale**

| Average of all aspects Company A: | 2,80 |
|---|---|

Company A has an average score of 2,80 points (2,85 points if introduction questions included). Since the level of maturity will be calculated on the average score excluding the introduction questions aspect, the valid average score is 2,8. The maturity level for company A is **Level 3 - "Intermediate"**. Company A has the highest score with 4,20 points on a five-point scale on aspect A4: Customer interfaces. The second highest score with 3,18 points is for the introduction questions (If introduction questions excluded A7: Institutional awareness with a score of 3,0). The lowest score for Company A with 1,8 points is for aspect A3: Products and customer services. The second lowest score is for aspects A1: Strategy and Organization, A5: Value chain as well as A6: Technology with a common score of 2,6.
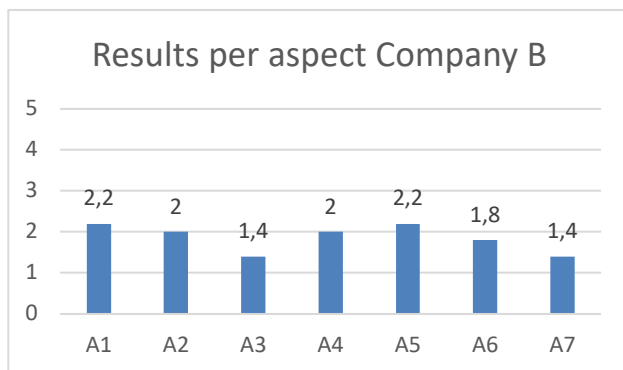


**Figure 2. Results per aspect for Company B on a 5-point scale**

| Average of all aspects Company B: | 1,9 |
|---|---|

Company B has an average score of 1,9 points (1,88 points if introduction questions included). Since the level of maturity will be calculated on the average score excluding the introduction questions aspect, the valid average score is 1,9. The maturity level for company B is **Level 2 - "Starter".** Company B has the highest score on a five-point scale on aspects A1: Strategy and organization and A5: Value chain with a common score of 2,2. The second highest score is on aspects A2: People and Organizational culture and A4: Customer interfaces with a common score of 2,0 (as well as introduction questions with a score of 2,0 if included).
The lowest score for Company B is for aspects A3: Products and customer services as well as for A7: Institutional awareness with a common score of 1,4. The second lowest score with 1,8 points is for aspect A6: Technology and IT management.

## *4.2 SIMS SCAN RESULTS AND ANALYSIS*

All scores for both companies can be found in Table 1 as well as Figure 1 and Figure 2.The scores are based on a five-point scale rounded up to two decimals.

### *4.2.1 RESULTS INTRODUCTION QUESTIONS*

Since every market or sector is different when it comes to stability, dynamic or the speed of growth and development. The introduction questions show the status of the Industry 4.0 implementation process of the whole market the company is operating in and displays the company's ability to anticipate the development of Industry 4.0 in the market.

| Score for introduction questions –<br>Company A (CA) | 3,18 |
|---|---|

From the introduction questions we can conclude that the employees of company A see the general industry sector of the company as a fast growing one with fast growing sales. Inside

the sector there are fast changes taking place but these changes are not unpredictable so we can conclude that there are fast changes but in a stable, predictable environment. There are not a lot of newcomers in this sector with innovative ideas but the competitors already operating in the sector are constantly trying to fight their products with cheaper "replacement-products". To underline this, it is to say that there is a lot of competition in this sector but also a lot of possibilities to gain more revenue, for example in niche markets where the revenue is also growing very fast now.

| Score for Introduction questions –<br>Company B (CB) | 2,00 |
|---|---|

From the introduction questions we can conclude that the employees of company B see the general industry sector of the company as a slow growing one but for newly discovered niches inside the market the sales are growing fast. Inside the sector there are nearly no changes taking place so it can be described as a stable, predictable environment. There are not a lot of "newcomers" in this sector with innovative ideas but the competitors already operating in the sector are constantly trying to fight their products with cheaper "replacement-products". To underline this, we can conclude that there is a stable environment in this industry sector with no major changes taking place. Since there are not a lot of newcomers in the sector, competition is restricted to companies already operating in the sector. Growth is somehow restricted to niche markets inside the sector.

### *4.2.2 RESULTS ASPECT A1: STRATEGY AND ORGANIZATION*

In organizational strategies, the increase of the importance of Industry 4.0 cannot be overlooked. Aspect A1 measures the extent to which the company's strategy contributes to an organization in which Industry 4.0 can be integrated.

| Score for aspect A1:<br>Strategy and organization – CA | 2,60 |
|---|---|

The employees of Company A responded that Industry 4.0 is not integrated into the company's overall strategy. However, digital products and services play an important role regarding the value creation of the organization. The process of the integration of industry 4.0 into the company's overall strategy is not specially observed. All in all, it is to say that even digital products and services play an important role for the company as well as innovation and data processing, there is not great effort to implement Industry 4.0 implications.

| Score for aspect A1:<br>Strategy and organization – CB | 2,20 |
|---|---|

The employees of Company B responded that Industry 4.0 is integrated into the company's overall strategy on a very low level. Digital products and services do not play an important role regarding the value creation of the organization. The process of the integration of industry 4.0 into the company's overall strategy is not specially observed. Nevertheless, innovation plays an important role for the company's overall strategy and a lot of data will be used to create more value for the organization and its operations.

### *4.2.3 RESULTS ASPECT A2: PEOPLE AND ORGANIZATIONAL CULTURE*

When it comes to organizational changes or applying innovations, the employees of a company play an important role. The questions of aspect A2 measure to what extent there is a culture within the company that facilitates that.

| Score for aspect A2:<br>People and organizational culture – CA | 2,80 |
|---|---|

The employees of Company A view the company's organizational culture as a culture that is not aware of Industry

4.0 implications. In addition, the employees are not being trained for possible future needed skills regarding industry 4.0 implications, even they would have the ability to adapt and learn the needed skills fast and the motivation to do so is currently provided.

| Score for aspect A2: | |
|---|---|
| People and organizational culture – CB | 2,00 |

The employees of Company B view the company's organizational culture as a culture that is not aware of Industry 4.0 implications, as well as the management. Furthermore, the employees are currently not being trained for possible future needed skills regarding industry 4.0 implications. It is also to say that the ability of the employees to learn Industry 4.0 related skills fast is only provided on a low level. In summary, the organizational culture as well as the people that are part of the company are not aware of a possible integration of Industry 4.0 soon.

### 4.2.4 RESULTS ASPECT A3: PRODUCTS AND CUSTOMER SERVICES

Products are currently increasingly being provided with so-called smart technologies and closely linked to customer-related services. The questions of aspect A3 measure the extent to which the company's products are equipped with smart techniques and in which of them customer-related services are offered.

| Score for aspect A3: | |
|---|---|
| Products and customer services – CA | 1,80 |

According to the scores for aspect A3, the products and services that company A is selling are equipped with smart technologies only on a very low level. Industry 4.0 is also almost not integrated into any products they are selling. In addition, Industry 4.0 is almost not integrated into the production processes of the company. However, customer feedback is constantly used for improving their products but there are no Industry 4.0 features integrated into this process.

| Score for aspect A3: | |
|---|---|
| Products and customer services – CB | 1,40 |

According to the scores for aspect A3, the products and services that company B is selling are equipped with smart technologies only on a very low level. Industry 4.0 is also almost not integrated into any products they are selling. Furthermore, Industry 4.0 is almost not integrated into the production processes of the company. However, customer feedback is constantly used for improving their products but there are no Industry 4.0 features integrated into this process. Additionally, Industry 4.0 is not used to satisfy the customers in any way.

### 4.2.5 RESULTS ASPECT A4: CUSTOMER INTERFACES

Customer interfaces describe the way a customer can get in touch with the company. The questions related to aspect A4 measure the extent to which the organization provides digitized contacting possibilities.

| Score for aspect A4: | |
|---|---|
| Customer interfaces – CA | 4,20 |

The employees of Company A responded that customers regularly use the internet to get in contact with the company and in addition, there are a lot of other channels that are used to communicate with customer or get in contact with them. There is a medium use of data to better analyze customer's needs. To conclude that, the overall process from getting in contact with a customer to the triggering of an order is almost completely digitized.

| Score for aspect A4: | |
|---|---|
| Customer interfaces – CB | 2,00 |

The employees of Company B responded that customers generally use the internet to get in contact with the company. There are currently not a lot of alternative channels to communicate with customers. Currently, there is not data used to better analyze the needs of customers. All an all, the only digitized aspect regarding to the customer interface of Company B is getting in touch with customers through the internet.

### 4.2.6 RESULTS ASPECT A5: VALUE CHAIN

The questions concerning aspect A5 measure the maturity of Industry 4.0 regarding the value chain of the company, so basically from the customer expressing the demand to the delivery of the product.

| Score for aspect A5: | |
|---|---|
| Value Chain – CA | 2,60 |

The employees of Company A say that there is an overall focus on digitizing the value chain. Since they are not a producing or manufacturing company, no data can be gathered during the production process for possible improvements. Thus, there are no smart-techniques used because there is no production process. There is a moderate interconnection of the used software, hardware, and other equipment regarding the value chain.

| Score for aspect A5: | |
|---|---|
| Value Chain – CB | 2,20 |

The employees of Company B say that there is almost no focus on digitizing the value chain. However, there are data gathered within the production process to improve the process in the future and here, smart technologies are used. There is only a small interconnection of the used software, hardware, and other equipment regarding the value chain.

### 4.2.7 RESULTS ASPECT A6: TECHNOLOGY- AND IT-MANAGEMENT

Adding smart functions to products and services as well as smart technologies in general plays an important role in modern societies. The questions regarding aspect A6 measure the extent to which the company has added smart technologies to their products.

| Score for aspect A6: | |
|---|---|
| Technology and IT Management – CA. | 2,60 |

The employees of Company A responded that the company does not make use of Industry 4.0 technologies now. Furthermore, the staff of Company A regarding the IT-department does not have sufficient knowledge to implement Industry 4.0 technologies. However, there is sufficient data-protection given and a lot of data is used to make decisions based on day-to-day operations in real time.

| Score for aspect A6: | |
|---|---|
| Technology and IT Management – CB. | 1,80 |

The employees of Company B responded that the company does not make use of Industry 4.0 technologies and the IT-department does not have sufficient knowledge to implement those technologies. There is no data used to make automated real-time decisions.

### 4.2.8 RESULTS ASPECT A7: INSTITUTIONAL AWARENESS

Privacy, security, and legislation are becoming more and more important, especially when it comes to the integration of Industry 4.0. The questions of aspect A7 measure the extent to which the company is able to handle the associated measures and to what extent the company is actually aware of the importance of these terms.

| Score for aspect A7: | |
|---|---|
| Institutional Awareness – CA | 3,00 |

The employees of Company A reported that the digital-business policies of Company A are up to date. The overall intellectual property of the company is protected on a high level. However, the employees of Company A do not have sufficient knowledge about rights and taxes that come along with the integration of Industry 4.0. Currently, the company is able to disclose customer data regarding the European Privacy Legislation and the General Data Protection Regulation (GDPR).

| Score for aspect A7: Institutional Awareness – CB | 1,40 |
|---|---|

The employees of Company B reported that the digital business policy is not sufficiently developed. There is a moderate protection of the company's intellectual property. Company B is currently not able to disclose customer data regarding the European Privacy Legislation and the General Data Protection Regulation (GDPR) and is not aware of possible tax effects or rights that come alone with the implementation of Industry 4.0.

## 4.3 FOCUS GROUP RESULTS AND ANALYSIS

The questions that were asked during the Mini-Group workshop can be found under Appendix A. Since we are interested in the impairments of customers and suppliers on the Industry 4.0 integration regarding SMEs, the questions that were asked which led to the desired discussion among the employees of both firms were related to the three lowest scores for both companies. This provided insights on how the customers and suppliers interfere the process of improvement of these fields of Industry 4.0. The results are displayed in two sections, one for the interferences of customers and suppliers that the companies are facing and one for possible strategies and solutions the companies are currently using or thinking of using in the future. To provide discretion for both companies since the information are currently still seen as trade secrets, the results are displayed without direct allocation regarding company A and B.

### 4.3.1 FOCUS GROUP RESULTS OF INTERFERENCES THE COMPANIES ARE FACING

One of the companies responded that there is a high focus on automated merchandise management systems within the company. For example, the company has suppliers with whom they have an automatic inventory comparison. That means, that the company does not store the items needed from the supplier itself in their own warehouses but work with the stock of the supplier and thus order the items from the supplier in the moment where a customer places an order. Concerning this strategy, the company faces problems regarding the supplier because the supplier does not have sufficient technology integrated into their operations to handle the process in the best way possible. One of the companies also responded that they are currently still using Excel tables to map their inventory which still need to be processed manually. Changing this strategy towards a more digitized, interconnect Industry 4.0 strategy of mapping and processing inventory is currently not possible because the suppliers, the customers, and the company itself all have different merchandise management systems as well as technology like servers, devices and software that currently cannot interact with each other. Furthermore, one of the companies is facing a hurdle concerning the ability to further satisfy the customer with Industry 4.0 aspects that could be integrated into the products or services of the company. For example, if the customer could be further satisfied by integrating an automated re-order point for products that are used on a daily basis, the customer also needs to track its inventory to know how much of the products are left and when to notify the company that the re-order level is reached.

Concerning Industry 4.0, this process needs to be automated so the customer also needs a system that supports the automated re-order strategy as well as the tracking of inventory. The company responded the perception that their customers have so far not put any value on such systems and are not aware of the benefits coming along with such a system. According to the value chain of one of the companies, the discussion's participants responded that there is almost no direct connection between the company's hardware, software, and other equipment and those of the suppliers and customers. Based on that, delays within the value chain so if the supplier cannot deliver the products on time cannot be easily tracked because the technology used by the supplier is not supporting automated delay-notifications. The company then must contact the supplier manually and ask for the reason and the time frame of the delay. Furthermore, the company faced that most of their suppliers are not willing to disclose information, for example about their inventory or even their overall strategies. For example, the system of working with the supplier's stock rather than storing the products in their own warehouse is not working with all the suppliers because the suppliers do not want to disclose their information since they fear to lose competitive advantages over other suppliers. One of the companies additionally responded that the employees have noticed that customers are currently mostly not willing to deal with new technology. That is basically the reason why they keep working with "older" technology because the customers know these technologies and the risk of losing customers can be minimized or kept on the same level.

### 4.3.2 FOCUS GROUP STRATEGIES TO AVOID INTERFERENCES ON THE INDUSTRY 4.0 IMPLEMENTATION PROCESS

During the Mini Group Workshop, the employees of the companies were also asked to give possible strategies they are currently using or planning to use in the future to avoid possible interferences of customers and suppliers on the Industry 4.0 implementation process of the companies.

One of the companies responded that there are mostly different merchandise management systems regarding the company itself and its suppliers and customers. These systems mostly cannot interact with each other, so automation is almost not possible. According to the company, this problem can be tackled by having employees in the own IT-department that are able and have the knowledge to develop own interfaces between the different merchandise management systems so that for example, stock information can be received automatically and in real-time. The company answered, that having own employees with such a knowledge is easier than convincing suppliers and customers to update their systems towards one that is more open to Industry 4.0 implementations.

In addition, one of the companies responded that customer services are mostly not digitized and that there are almost no Industry 4.0 implementations integrated into their products. According to the services, the company saw that it could be very helpful for customers that re-order products on a continuously basis to give insight about their stock so that re-order levels can be created, and orders can be placed automatically. Since most of the customers of the company do not track their own stocks, the company said that taking responsibility for the customers and take over the development of the required systems for the customer can help to break this barrier. Furthermore, one of the companies responded that there is a barrier regarding the transparency of customers as well as suppliers. The suppliers of the company are currently not willing to reveal data like stock data or production prices or machine running time or specific data about delivery processes.

The company responded that it feels like the supplier tries to hide every data that could lead to a decline of their competitive advantage. However, the company said that this data is needed to implement automated, Industry 4.0 related systems and this barrier can be removed if there would be a way to show the customer that reducing transparency would lead to benefits for both the company as well as the supplier while providing enough transparency to maintain their competitive advantage in the supplier market. The company also responded that this can be done by building trust and loyalty to the supplier, showing that there is no risk.

# 5. DISCUSSION

This chapter includes the comparison of the empirical results, so the results from the SIMS scan as well as from the Mini Group Workshop, and the literary findings. Furthermore, theoretical, and practical implications are discussed and the need for solutions regarding the interferences of customers and suppliers on the Industry 4.0 implementation process of SMEs is formulated.

## 5.1 THEORETICAL IMPLICATIONS

With the undertaken research, interferences of suppliers and customers on the Industry 4.0 implementation process of small- and medium sized enterprises have been found out and possible strategies to overcome these interferences are mentioned. In this section, the interferences that were noticed by the participated companies of the Mini Group workshop are compared to the literary findings.

The first thing to mention is that one of the participating companies perceived a lack of sufficient technology regarding their suppliers which is making an implementation of Industry 4.0 aspects difficult. This statement is in line with the statement of Müller, Veile and Vogt who say that the suppliers need an appropriate infrastructure concerning their technology and that there need to be sufficient knowledge about Industry 4.0 (Müller, Veile, & Voigt, 2018). Moreover, one of the companies responded that there are different merchandise management systems regarding the company, its suppliers, and customers. These differences make it difficult to implement Industry 4.0 aspects like automated stock exchanges. Müller, Veile and Voigt (2018) also investigated this problem, pointing out that Industry 4.0 tries to enable a global network of interconnected systems that autonomously work together. Talking about customer satisfaction, one of the companies is willing to integrate automatic re-order levels so that the customer does not run out of items that are for example needed daily. The interference at this point is, that the customer is yet not willing to track its stock which is needed for integrating such a system. Müller, Veile and Voigt (2018) as well as Kiel et al (2017) mentioned a challenge for the integration of Industry 4.0 is the openness and willingness to cooperate on both sides, so the supplier or customer as well as the company. In addition, Müller, Veile and Voigt (2018) pointed out that many customers or suppliers do not pay attention to the urgency of the Industry 4.0 implementation and therefore do not have a pro-active attitude towards the implementation process. Talking about automatic re-order points and stock information of suppliers or customers, one of the companies is facing unwillingness of both suppliers and customers to disclose data about their stock or also about delivery process information like delays because there could be a risk of losing competitive advantage by doing so. Regarding their customers, they noticed that customers are often not willing to disclose personal data or do not agree with the storage of personal data. These statements are in line with Müller, Veile and Voigt (2018) who also found

out in their research that company's suppliers are facing uncertainty when it comes to data security and protection and thus are unwilling to adapt the aspects of Industry 4. Additionally, they pointed out that organizational data is currently treated as a trade secret and that suppliers mostly do not have the intention to disclose their data which is needed for the implementation of Industry 4.0 (Müller, Veile, & Voigt, 2018). According to the customer in this statement, companies must be able to efficiently use new customer data as well as old, stored data (Hood et al., 2016). Talking about customers again, one of the companies responded during the Mini Group workshop, that their customers are currently not willing to deal with new technology in general and thus use the given technology without focusing on interconnection, smart products, digital data disclosure or other Industry 4.0 related technology. The statement of Hood et al, that there is a lack of visibility on the usage of products regarding customers underlines the statement of the results of the Mini Group workshop.

## 5.2 PRACTICAL IMPLICATIONS

Using the Smart Industry Maturity Scan (SIMS) can be very useful to find possible interferences of a company's suppliers and customers on its Industry 4.0 implementation process. Regarding the outcomes of the scan for both companies, specific questions that were related to the low scores were asked to find out, if and how customers and suppliers have an impact on that score. The mixture of getting a status-quo on the extent to which the companies have Industry 4.0 integrated and directly confronting them with questions about the impact of customers and suppliers on the integration can give great insights on the cause, so why suppliers and customers interfere the process and on possible strategies to be able to foreclose these causes in the future. In this section, strategies that were mentioned by the companies during the Mini Group workshop to avoid customer as well as supplier interferences on the implementation process of Industry 4.0 are discussed and aligned with strategies from the literature. Additionally, more future implications will be displayed that can help companies to avoid the mentioned interferences in the future. To help companies in the future, these practical implications can be seen as recommendations for companies which want to avoid the mentioned interferences. Before talking about strategies that can be helpful, the very first thing to mention is that a company should explain the added value of integrating Industry 4.0 to their suppliers and their customers. Integrating Industry 4.0 can be a benefit for all parties involved, the company, its suppliers as well as its customers. Therefore, one of the participating companies of the Mini Group workshop responded that it is important to know the benefits coming along with the implementation for both sides and to be able to explain these benefits to the suppliers and to the customers in an understandable manner. One of the biggest disruptive factors regarding the suppliers of a company when it comes to the integration of Industry 4.0 is a lack of sufficient technology. Müller, Veile and Voigt (2018) mentioned that companies should make the requirements and standards coming along with the integration understandable for their suppliers. Furthermore, Müller, Veile and Voigt (2018) reported that making information available for all partners that are included in the value chain can be highly beneficial and communication, honesty and transparency can help to successfully implement the supplier. During the Mini Group workshop, one of the companies responded that a lot of suppliers are afraid of losing their competitive advantage by disclosing valuable information about the company. To prevent the company from facing this interference, contractual security is of high value. Müller, Veile

and Voigt (2018) say that suppliers generally aim at long-term contracts since investments are often made to benefit in the long run. This means that before suppliers are willing to invest into Industry 4.0, for example, into sufficient technology to enable Industry 4.0, contracts need to be created which guarantee the security of valuable information of the suppliers. To enable the exchange of information between the company, the suppliers but also the customers, well secured platforms can be made up (Müller, Veile, & Voigt, 2018). Moreover, new business models can be created where the suppliers are directly integrated (Müller, Veile, & Voigt, 2018). This can enhance the commitment of suppliers according to the implementation of Industry 4.0. A last thing to mention here is that one of the companies which participated in the Mini Group workshop suggested to take over the implementation of necessary technology, processes etc. for the supplier. If the company is capable of doing so regarding the staff, the knowledge and the resources, this could be a good way to optimize the connection of systems and other necessary implications between the supplier and the company.

Focusing on the customer and on the mentioned platforms again, Deloitte (2016) found out that building new platforms that combine marketing information and customer information to come up with new marketing processes as well as sales processes can be crucial for the implementation of customers into the Industry 4.0 implementation process of companies. During the Mini Group workshop, one of the companies responded that customers are not willing to share their data, too. At this point, companies should focus on what was said before, making the added value for the customer as understandable as possible and help the customer to fully understand the technology, requirements and standards that come along with the integration of Industry 4.0. Moreover, making sure that shared data is protected is crucial here, too. The company also responded, that building trust and loyalty can help customers as well as suppliers to have less risk sharing their information which can be aligned with the long-term contracts with customers and suppliers that were mentioned before (Müller, Veile, & Voigt, 2018). To underline this chapter, it is to say that almost every interference that was found in the literature was taking place in reality according to the companies that participated in the Mini Group workshop. Moreover, the companies were aware of most of the strategies displayed based on the literature or were actually using these. Based on the findings, Table 2 illustrates the most important interferences and possible strategies to avoid these interferences as an overview so that companies can recognize the interference and thus act with the according strategy to avoid or stop this interference.

Table 2: Interferences of suppliers and customers on the implementation process of Industry 4.0 for SMEs and strategies to avoid these

| Interferences of customers and suppliers | Strategies to avoid or overcome these interferences |
| --- | --- |
| Lack of sufficient technology regarding the suppliers (hardware, software, equipment) | Make requirements and standards understandable and attract the customer or supplier by pointing out the benefits coming along |
| Different merchandise management systems of company and suppliers/ customers | Again, pointing out the benefits of same or interconnectable systems that are up to date. Convince the supplier or customer, that sharing information is crucial for working interconnected. Force the supplier or customer to have IT-Staff that is able to build interfaces between the systems. |
| Customers are often not willing to track data about their stock so that automated re-ordering cannot take place | Communication, honesty, and transparency followed by contractual security can minimize the hurdle for customers and suppliers to disclose their data |
| Customers and suppliers are not open or willing to cooperate with the company | Again, convincing the supplier or customer that the benefits are outweighing the costs. Additionally, the company can create new business models that have the customers and suppliers integrated to motivate their commitment and to show that this is based on long-term. Use the relational transformation framework by Kamalaldin et al. (2020) |
| Customers and suppliers do not pay attention to the urgency of Industry 4.0 and do not have a pro-active attitude | Making suppliers and customers aware of the ongoing 4th Industrial revolution. Using the SIMS scan mentioned in this research can help to identify the maturity level of the customers and suppliers and to make them aware of future changes in the market |
| Customers as well as suppliers see a risk in disclosing data about their companies or personal information | Data security is crucial for implementing Industry 4.0. Therefore, contractual security can help minimizing this hurdle as well as understandable, protected platforms for interchanging information |
| Organizational data is currently treated as trade secret, giving competitive advantage for suppliers | Again, data security is very important for all parties within the value chain. Long-term contracts can eliminate a lot of risk for suppliers and customers which need to disclose data |
| Customers are not willing to deal with new technology, for example, smart products or interconnectable products because their currently used technology works well | Making the customer aware of the benefits coming along with smart products and that these benefits outweigh the costs coming along. Make new technology as understandable as possible. |

## 5.3 LIMITATIONS AND FUTURE RESEARCH

There are several limitations coming along with this research. The factor that this research is a research based on a bachelor thesis, the time frame for finishing this research was limited. Because of the COVID-19 situation, it was even more difficult to find companies that are willing to participate in this research within the given time frame. Normally, the Mini Group workshop would have taken place at the company's location but due to the COVID-19 situation, only video conferences were possible. Furthermore, a lack of information about customer interferences on the implementation process of Industry 4.0 regarding SMEs was noticeable which makes it difficult to give enough insights about the topic and to give possible strategies to overcome these interferences. Moreover, both companies have a low maturity according to the implementation of Industry 4.0 which made it difficult to give examples on how to avoid interferences of customers or suppliers. Having an SME which has inserted Industry 4.0 to a splendid degree could have shown examples on how to avoid or minimize the interferences and this information could have been used by other companies in the future. For future research, it is recommended to find such an SME which is willing to participate in the research. Moreover, the participating companies operate in different markets. Company A is a retail company selling goods through the internet and Company B is a traditional manufacturing company selling sealing systems and elastomer profiles for sewer construction, tunnel construction or other applications. Since Industry 4.0 is based on the IoT, Company A seems to have more knowledge about the technologies coming along with Industry 4.0 because it is their day-to-day business where Company B does not need to focus on Industry 4.0 implications yet. Thus, the number of participating SMEs should be increased so that bias regarding the market the SME is operating in can be minimized.

## 6.     CONCLUSION

This research tries to comprehensively point out possible interferences of customers and suppliers on the Industry 4.0 implementation process of small-and medium sized enterprises. By using the Smart Industry Maturity Scan (SIMS scan) provided by the company Ixia Smart Insights, a status-quo of the maturity level of two participating companies was drawn. Using the results from the scan, a Mini Group workshop was held with the companies where the lowest scores that the companies scored were discussed. In this discussion, questions were asked on possible causes why the score was low and to what extent the company's customers and suppliers had an impact on that low score. Additionally, the companies were asked to give possible strategic options to overcome these interferences or to avoid them. Following the results of the mentioned techniques, theoretical and practical implications were drawn to help companies identifying possible interferences and overcome or avoid these in the future. According to this, this research can be seen as an addition to the current knowledge in the investigated field of Industry 4.0. By doing this research, a lack of knowledge about the special field of interferences of customers and suppliers on the Industry 4.0 implementation process of SMEs was noticed which makes it very interesting and shows that further research needs to be done. Since growth plays an important role for small and medium sized enterprises, it is crucial for them to identify barriers that interfere with the desired growth. The main interferences according to a company's Industry 4.0 implementation process that were found in this research are the lack of sufficient technology regarding the suppliers, so software, hardware and other equipment which is currently not

mature enough to implement Industry 4.0 functions, the lack of interconnection between used systems, for example the merchandise management system, no awareness about the urgency of Industry 4.0 technologies by the supplier or customer and thus not willing to cooperate with the company, no awareness about the need for smart products and a lack of trust according to the disclosure of valuable data. According to the investigations in this research, long-term contracts with suppliers and customers form a good start to avoid or overcome the mentioned interferences. Long-term contracts can minimize the risk for suppliers or customers to disclose their data since doing so can be beneficial for all parties involved. If the supplier or customer knows that the business relationship with the company is long-term, it makes it easier to disclose data. Based on a long-term contract, the company should focus on trust, loyalty, honesty, and communication. Communicate the benefits coming along with the integration of Industry 4.0 is crucial so that customers and suppliers see that investing in such technology is worth it. Moreover, the interconnection of such systems is important. For doing so, the exchange of data is necessary again. To strengthen the trust, contractual security can help making data disclosure less risky for suppliers and customers. To underline this conclusion, building a long-term and secured relationship between the company and its suppliers and customers is important and can open the door for further Industry 4.0 implementations. It can help suppliers and customers see the urgency of Industry 4.0 and support them with the integration of needed technology, interconnection between systems, data disclosure or the willingness to cooperate and accepting that the digitization can be of high value for everyone within the value chain.

The main limitation of this research belongs to the small sample size of only two participating companies. Furthermore, including suppliers or customers of the participating companies would have provided deeper insights on the interferences. Moreover, the participating companies both have a low maturity level so including SMEs which have a high maturity level could have provided more insights about the used strategies to overcome the interferences of suppliers as well as customers. With this knowledge, more precise recommendations could have been drawn for companies that are facing these hurdles in the future.

## 7.     ACKNOWLEDGEMENTS

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# 9. APPENDICES

## 9.1 APPENDIX A: List of questions asked by the moderator during the Mini Group workshop

Table 3: A list of questions asked by the moderator during the Mini Group workshop

| Number of Question | Questions asked by the moderator during the Mini Group workshop |
|---|---|
| Q1 | To what extent do you think that your suppliers and customers interfere the integration of Industry 4.0 into your overall business strategy and what are your strategies to avoid such interferences or minimize them? |
| Q2 | To what extent do you think are suppliers and customers of your company prevent you from integrating Industry 4.0 into your production processes and how do you think you could overcome these barriers? |
| Q3 | Do you think that your customers and suppliers interfere the integration of smart technologies as well as the inclusion of smart products into your product portfolio? |
| Q4 | According to your value chain, to what extent do you think that your suppliers and customers disrupt the integration of Industry 4.0 aspects to the value chain of your company and what strategy can you imagine or are you using that could help integrating your suppliers and customers into this integration process? |
| Q5 | To what extent do you think that your suppliers and customers interfere the innovation process of your company? Do you think that suppliers and customers can actually help the company to force innovation? |
| Q6 | When it comes to the organizational culture, do you think that your suppliers and customers have an impact on the awareness of your employees regarding Industry 4.0 and if there is a negative impact, how can that be changed? |
| Q7 | Regarding the customer contact, do you think that your suppliers or customers prevent the integration of more digitized channels for communication? How do you think you could overcome these barriers? |
| Q8 | Regarding data security, researchers previously found out that the integration of Industry 4.0 is negatively affected by suppliers and customers that are not willing to share their data. Would you confirm this assumption? What do you do to avoid this interference? |