The Buyer-Supplier Relationship in Industry 4.0

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ABSTRACT,
It is only the start of researching what impact Industry 4.0 can have on business functions such as procurement and supply management. For this reason, this paper explores the changes to the relationship of the buyer and suppler in Procurement 4.0. Based on literature and a company visit, this paper provides an overview of the new way procurement is being done. It shows that there will be a supplier platform, with the goal to facilitate free information flow between buyers and suppliers. Factors that will influence that outcome include the support of management, technology, the will for collaboration and trust, regulation, standardization and new procurement skills.

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Keywords
Industry 4.0; Procurement 4.0; Smart industry; buyer-supplier relationship; platform-based integration; information exchange

11th IBA Bachelor Thesis Conference, July 10th, 2018, Enschede, The Netherlands.

1. INTRODUCTION

After the invention of steam-powered machinery in the 18th century, industries have been revolutionised more than once, leading to the invention of even more advancements. After steam machines, the discovery of electricity - the second big industrial revolution in the 19th century - changed the world (von Tunzelmann, 2003). Then, at the end of the 20th century, a major paradigm shift occurred through the introduction of computers and the internet to private consumers and businesses. As a result, new ways of working have emerged, and fundamentally changed how the world functions. These events have been essential drivers in the rapid development of new internet-based services and platforms (Kagermann, 2015), which have the important characteristic of connecting different devices with each other, creating a network known as Internet of Things. Together with new Cyber-Physical Systems, the way was free for new technologies such as high-tech machinery and autonomous robotics etc. (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014).

This has led to the new term Industry 4.0 (I 4.0), which not only changes technologies, but the way business is done. Most commonly, it is discussed with regard to production processes and manufacturing – making production smart by automating and connecting machines and products - thus I 4.0 is also called Smart Manufacturing in some areas (O'Donovan, Leahy, Bruton, & O'Sullivan, 2015). This can be projected onto a bigger picture, making supply and value chains smart by integrating I 4.0 (Kagermann, 2015). To be able to facilitate it, other business activities will have to adapt accordingly. Examples of those areas are the human research department, which needs to select more IT-skilled employees, the R&D department, to further develop technologies, and the purchasing departments, which will have to conform to a more closely collaborating network of suppliers.

For most people who do not work in the manufacturing industry, I 4.0 is largely unknown. This can also be seen in a survey mentioned by (Glas & Kleemann, 2016; IfDAllensbach, 2015) in which 1.393 Germans have been questioned whether they knew I 4.0, of which 83% have never heard about Industry 4.0 before. Regarding those having heard about it before, almost 60% did not exactly know what it was. Even now, three years later, it seems like many, who are outsiders to the manufacturing industry, do not know what I 4.0 is and have never heard of it. Further, it is only the start of researching what impact I 4.0 can have on business functions such as procurement and supply management (Glas & Kleemann, 2016). Thus, there is little known in regard to the integration of I 4.0 and the technology standing behind the innovations of the fourth industrial revolution when they are integrated into other business functions (Glas & Kleemann, 2016).

One specific topic, that has got little attention so far, is the relationship between companies in a supply chain or network. Oftentimes, this relationship is discussed in the context of Purchasing and Procurement 4.0 (P 4.0), a development resulting from the outcomes of Industry 4.0. So far, it cannot be predicted what P 4.0 will exactly look like, though one thing is for sure: businesses will see major changes in how they are cooperating in the future (Kleemann & Glas, 2017).

Much research still needs to be conducted to fully understand the full extent of Industry 4.0 on companies and networks of companies. Therefore, this paper will explore this matter and its effects on how information exchange will have to be adjusted to support the smart manufacturing processes and turn companies into an I 4.0 business. To be more precise, this research investigates how the previously mentioned information-flow will likely look like between supply chain partners and which factors might play a role in the process.

So, based on this objective, the following questions have emerged:

Research Questions:

How will the information exchange between buyer and supplier look like in Industry 4.0?

and

What factors will be important to facilitate this information exchange between buyer and supplier?

This article is going to present a picture of how the exchange of information and the relationship between buyers and suppliers will probably look like, according to what is currently known. This will be done by research review including some of the leading works by Kagermann (2015) and Glas and Kleemann (2016). Additionally, this paper will deliver an overview on the importance of factors that will most likely have an impact on the successfulness of industry 4.0 in a supply network/chain.

2. THEORETICAL FRAMEWORK

2.1 Digitisation

After the first and second industrial revolutions in 18th and 19th century, a major change has been brought about to the world, resulting in the introduction of automated technology and computers in the second half of the 20th century. Oftentimes, these developments are called the *Third Industrial Revolution* (Wollschlaeger, Sauter, & Jasperneite, 2017) and are generally known as *Digitisation.* According to Kagermann (2015, p. 24) digitisation is "the networking of people and things and the convergence of the real and virtual worlds that is enabled by information and communication technology (ICT)". Thus, it is providing different means to build new areas of working and existing, by using hardware and software and interconnecting devices with each other to facilitate communication.

Moreover, Wollschlaeger et al. (2017) suggest that this "powerful driver of innovation", seen in ICT, will "transform all key infrastructures […] such as energy, mobility, healthcare and manufacturing" (p.24). It is also seen as a key facilitator (Batran, Erben, Schulz, & Sperl, 2017) which needs to deal with disruptive events in the future. Moreover, this revolution did not only have an immense impact on the way organisations could operate, but also on the way products will look like, as technologies could become part of the product itself (Porter & Heppelmann, 2014), e.g. mobile phones, personal computers. Hence, the life of consumers changed accordingly because IT-capable devices have become universally available to anyone's personal use.

2.2 Industry 4.0

Ever since the Hannover Messe in 2011, where I 4.0 had first been announced (Kang et al., 2016), it has become one of the new buzzwords when talking about the future in business. The term *Industry 4.0* has been created and pushed in an agenda set by the German government (Kagermann, 2013) to stimulate innovation in organisations. It is also known as *Smart Industry, Smart Manufacturing, or the fourth Industrial Revolution* (Lasi et al., 2014). Yet, some argue that I 4.0 is not that revolutionary after all. They claim that the technology as such is facing predictable developments, which does not entail a revolutionised outcome. In contrast, to justify the revolutionary aspect, Spath et al. (2013)

states: “Industry 4.0, in the way that it is introduced is evolutionary. […] However, its impact will be enormous, which is revolutionary” (Translated from German; Spath et al., 2013, p. 48). Therefore, the understanding of the terms come down to a new concept which combines production processes with smart technologies, that will change the way industries work and make them more time, cost and resource efficient (Lasi et al., 2014). Not only the way of producing is going through some serious changes, the products themselves are being transformed into smart devices 'telling' machines how they want to be produced. Hence, automation and autonomation are being crucial aspects of I 4.0, as machines are connected in so called Cyber-Physical Production Systems (Monostori, 2014). These, together with the Internet of Things (IoT) are the two big backbones of I 4.0 as they are mentioned in numerous research papers as part of the explanation of I 4.0. This can be seen in Figure 1 when comparing the content of research papers on scopus.com with the search results "Industry 4.0". This illustrates that I 4.0, CPS and IoT are often connected in research.

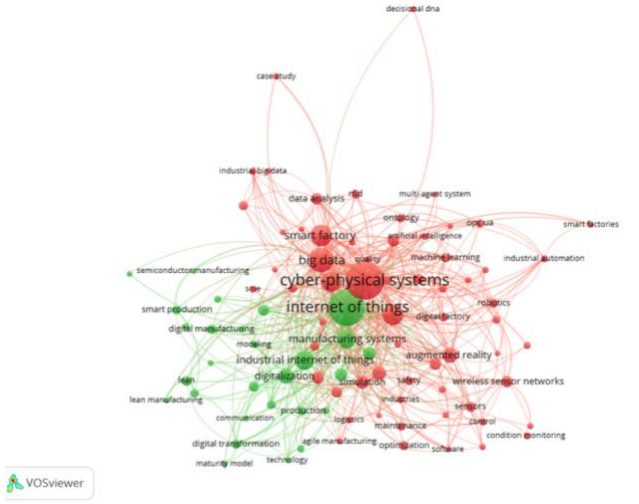

Figure 1. Cyber-Physical Systems and Internet of Things as clusters of Industry 4.0 (in VOS Viewer)

In addition, I 4.0 changes the way products are manufactured, since machines will become part of a smart, modular system which is more flexible and can adapt well to new processes. This enables the production of very mall batch sizes, while not having cost as a burden. Thus, the term 'batch size one' is increasingly mentioned, which is often used to describe highly individualised products of which only one piece needs to be manufactured (Sauter, Bode, & Kittelberger, 2015).

Further, through the use of data analytics, it becomes easier to anticipate and predict events to happen, e.g. predictive maintenance can prevent the breakdown of a machine and requests spare parts and reparation in time, so that down-time of the machine can be kept as low as possible (Li, Tao, Cheng, & Zhao, 2015). Other advantages of I 4.0 include shorter development times because the capacity to innovate grows (Lasi et al., 2014), increased resource and cost efficiency, as resources can be delivered and produced just-in-time – which tries to reduce stock as much as possible and only deliver and produce when there is demand (Hofmann & Rüsch, 2017).

Despite all the known aspects of I 4.0 that have previously been described, no actual definition has been published yet, as researchers did not yet agree on a unified definition. This might be one reason why companies have different understandings of what it entails (Glas & Kleemann, 2016) and often assume they are part of the development, though hardly any of the mentioned aspects are incorporated into the business practices.

Industry 4.0 does not only imply changes in technology that make production processes and logistics smarter. It also demands that there will be severe changes to the company and its environment. As Kagermann (2015) states, there will be a “shift away from competition between individual companies to competition between corporate networks” (p.32).

2.3 From e-Procurement to Procurement 4.0

The impact of Industry 4.0 on the relationship between buyer and supplier is most often described as part of the procurement activity of an organisation since it is portrayed as the interface of the supply chain and the organisation. Procurement is one of the most important activities in an organisation since it ensures the supply of resources needed for the production-processes of a manufacturing company. The core activities of procurement in a company include the assessment of demand; market analysis of procurement, analysis and evaluation of make-or-buy decisions, contracting and order handling, supplier management, strategic procurement and procurement controlling (Kleemann & Glas, 2017). With the development of technologies and their application in businesses, the procurement function had to adjust and make use of computers, the Internet and software tools, such as Enterprise Resource Planning (ERP) systems. As a consequence, the term e-procurement has emerged. E-procurement is defined as “the use of integrated information technology systems for procurement functions” (Croom & Brandon-Jones, 2007; Gunasekaran, McGaughey, Ngai, & Rai, 2009, p. 162), consequently, leading to the digitisation of procurement. Until this day, most companies are using some sort of digital technology, though the degree to which they use it might differ. One big aspect of e-procurement is that processes can be automated, such as order quantities and order times that will be sent based on predefined variables. Nonetheless, there is still the need for an employee to manually determine those variables and initiate the process. (Kleemann & Glas, 2017). Here lays one of the major differences to the newly emerged concept of Procurement 4.0. Since P 4.0 results from new developments of I 4.0, it is still in very early stages of its development. This can be seen as one of the reasons why there are few concrete cases in which Procurement 4.0 is applied in a company (Kleemann & Glas, 2017). Since a big aspect of I 4.0 is focused on the interconnectivity of devices and products, Procurement 4.0 deals with that too. Thus, according to Kleemann and Glas (2017), P 4.0 needs to ensure that new, changing objectives in product-requirements are met, e.g. that supplies are able to fit the inter-connectivity in the production. Next to that, P 4.0 has the task to deal, collect and analyse the data crucial for the decision-making process in purchase-related matters. Here, just like in the new developments of production, real-time data gains importance, e.g. buying- and contracting decisions can be based on current, relevant information. The same will be essential for ordering processes. Real-time data and increased automation are making the act of placing orders by employees unnecessary. Additionally, they state that the way a company chooses its suppliers will strongly depend on the analysis of supplier data.

2.4 Technologies in Industry 4.0

Due to the fact that I 4.0 is so dependent on technological advancements, the most important ones will be described in the following section:

2.4.1 Big Data

Big data is the main facilitator of all following technologies explained in this section. It describes the massive amounts of structured and unstructured data generated by all the devices connected to the Internet that are constantly used (SAS Institute Inc.). This includes e.g. smart phones, autonomous cars, computers, online activity, and production processes. The data as such does not have much meaning, it only becomes valuable when it is refined and analysed. So, Big Data Analytics can contribute to e.g. detecting trends and so helps to forecast (Sauter et al., 2015). For organisations, this is a method to optimise business operations and processes and, therefore, can lead to benefits such as lower costs, time savings, support in new product development and decision-making (SAS Institute Inc.).

2.4.2 Internet of Things (IoT)

The IoT is one of the important backbones of Industry 4.0. It describes the interconnection of objects through the Internet. First developed in the 1990s, it only really became prominent when "the number of devices connected to the network exceeded the number of inhabitants of our globe" around 2009 (Witkowski, 2017, p. 766). The IoT is a network made of a huge number of objects which are equipped with IP address, just like computers have to identify themselves (Scheer, 2015). These kinds of devices are often referred to as smart objects or smart products. There are "[t]hree distinguishing features of the Internet of things [, namely] context, omnipresence and optimization. The first refers to the possibility of an advanced object-interaction with an existing environment and its immediate response to change. The characteristic of context allows objects to provide information such as location, physical condition or atmospheric conditions. Omnipresence illustrates the fact that objects today are much more than just connections to a user network of human-operators. In the near future, they will communicate with each other on a large scale. Optimization is the expression of the functionality which every object possesses" (Witkowski, 2017, p. 766). The features of IoT support and facilitate the idea of I 4.0, as e.g. information about the products can be generated and analysed during the production process and products can be tracked from the beginning of production till the end of their life cycle.

2.4.3 Cyber-Physical Systems (CPS)

Lee, Bagheri, and Kao (2015) define CPS as "transformative technologies for managing interconnected systems between its physical assets and computational capabilities "(p.18). This means that these systems build a bridge between the actual, real and the virtual world, by using for example sensors and actuators that are integrated into the system "to record, evaluate and store data" (Sauter et al., 2015, p. 4). CPS enable the integration of networks via the Internet. In every-day life, CPS can be found in automated cars which scan the surroundings of a car and provide assistance in parking. In manufacturing, they are called cyber-physical production systems (CPPS), which are, according to Monostori (2014), "autonomous and cooperative elements and sub-systems that are getting into connection with each other in situation dependent ways […]" (p.10). This way, CPPS facilitate highly automated production processes.

Critically speaking, CPS and IoT appear to be very similar, which is true to the extent that they are made of the same architecture. While the Internet of Things creates a connection between all objects that are linked to it, CPS focus much more on the integration of both virtuality and reality.

2.4.4 Cloud Computing

According to the National Institute of Standards and Technology in the United States "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services)" (Mell & Grance, 2011, p. 2). So, instead of having to rely on actual, limited hardware to operate with, the cloud can serve as an alternative. Some major advantages of using the cloud are that it is accessible anywhere (as long as there is a supporting internet connection), which enables the cooperation of different actors in different geographical locations and can be used on demand, while providing endless computing capacity (Armbrust et al., 2010).

3. METHODOLOGY

To find an answer to the questions mentioned above, research was conducted which has mainly been based on the review of scientific literature. According to Webster and Watson (2002), a literature review serves as a tool to determine what prior, related research has found out, and thus, builds the base for developing new theories and frameworks. The literature used in this paper has been accessed via Scopus, Web-of-Science, Google Scholar and the research library of the University of Twente. Keywords during the search were e.g. *industry 4.0; smart industry; industry 4.0 and purchasing; procurement 4.0; industry 4.0 and supply chain; etc.* To further find relevant content, related articles have been browsed, and important references have been identified and taken into consideration. In addition to the usage of secondary data, at a company visit to the press brake manufacturer Wila in Lochem, questions could be asked on their approach of applying Industry 4.0. Despite their efforts to develop in a smarter direction, there was still a lack of actual application. Nonetheless, the visit gave insights into stages of development and troubles in terms of I 4.0.

After the literature review and company visit, the findings were combined and outlined on the state of information exchange between buyer and supplier as it is currently available. As for the second question, this paper will identify which factors will have a high level of relevance to facilitate successful information flow in industry 4.0. This will be done based on existing literature and the statements from the company visit. The factors were identified based on the overall importance that authors have given to the factor, the described essentiality of the factor on the developments, and the severances of the absence of the factor.

At the beginning of the research period, the Fabrication Laboratory (FabLab) at the Saxion University of Applied Science was visited and gave a first overview on the technologies and trends that are existing at the moment. Next, the visit to the company Wila esablished a better practical understanding of the current situation in manufacturing companies and how they develop and apply those technologies of Industry 4.0 that are most relevant to their industry. In addition, the Hannover Messe 2018 on the topic Industry 4.0 gave another opportunity to become familiar with the newest developments in technology.

Further, multidisciplinary research was conducted that combined insights from purchasing and engineering perspectives, including a discussion with an Industry 4.0 purchasing researcher at the University of Twente. Through this, the future direction of purchasing has been indicated and so, helped to decide on the direction of this research.

4. FUTURE OF PROCUREMENT

In the course of reviewing existing literature, it became clear that, despite the attention to I 4.0 and its vast developments in recent years, procurement was not given much attention in the events of revolutionising the industry. That is although it "is a fundamental conceptual element of Industry 4.0 as it connects the different supply chain partners and enables a dynamic and rapid cooperation and coordination beyond organisational boundaries" (Glas & Kleemann, 2016, p. 58).

As explained above, there is not yet much knowledge and data on the application of Procurement 4.0, because there are hardly any companies which are implementing aspects of the fourth industrial revolution into their procurement department. Consequently, the following identified possibilities are based on assumptions made by researchers. These are constructed around the technologies that are currently available and upcoming trends.

There has been one particular picture painted by numerous authors for the future for procurement and supply chains. Most commonly described there is a new, increased focus on cooperation between partners in the supply/value chain, which will be based upon using a platform-based network (Günthner, Klenk, & Tenerowicz-Wirth, 2017; Kagermann, 2013, 2015; Kleemann & Glas, 2017). This is made possible, because technologies such as cloud-computing systems and IoT have developed to an extent that several parties can access such a service all at once. As an ideal situation, such a platform would transform the exchange of information into a free flow of information. Kagermann (2015, p.30), as well as others, describe a network in which the manufacturing part of a company is integrated with the logistics and procurement and provides information instantly when requested (Batran et al., 2017). With help of such a cloud-based network, actors in the supply chain have easy access to information about their partners, i.e. their suppliers and their buyers. This will become the new form of exchanging information, simply by providing data, e.g. from production processes, product characteristics, locations, market information etc. Though, collaboration networks are not very new and have been around for quite some time. One of the actual revolutionising acts is that real-time data is introducing a new dimension, just like autonomously and automated systems that are interacting with each other.

The way companies are buying, will change dramatically with cloud-based platform cooperation. According to Batran et al. (2017), with intensification of cooperation, connectivity with regard to data and efficiency in the environment of a company on the basis of technological advancements, the procurement function has to adjust and change correspondingly. Most significantly, the actual ordering process is not being done by employees anymore (Kleemann & Glas, 2017). As another important aspect of Industry 4.0 which is very likely to happen, autonomous and automated software will act as a support tool for purchasers and partly take over the ordering process by analysing and evaluating data. Here, extensive historic and real-time data set the base for artificial intelligence to identify trends in demands and automatically send requests to suppliers, so that orders can be adjusted accordingly to the demand and be delivered at the right time, e.g. Just-In-Time, which describes the production and delivery as soon as there is demand (Hofmann & Rüsch, 2017). Suppliers will be chosen based on real-time data which shows their production performance, delivery performance, quality and price. The act of ordering will not only be supported by the new smart systems, but they will autonomously order based on information that have previously been analysed by the system (Kleemann & Glas, 2017).

Often, it is said that every company adopts those technologies that are most relevant and applicable to their business objectives (Wu, Cegielski, Hazen, & Hall, 2013). That indicates that every company has a different level of integration of I 4.0 technologies, and so, needs different solutions that are fitting to their digital and corporate strategy.

However, a company is not capable to establish procurement 4.0 on its own and should not be seen as an isolated unit (Kleemann & Glas, 2017). After all, the goal is to work with a network, so collaboration is needed between suppliers. The collaboration appears to be critical in the introduction of P 4.0 as well as for the integration of partners into the network. As Kipouridis, Günthner, Roidl, and ten Hompel (2013) say, if partners in a supply chain work together and develop such systems together, they might be put into place faster and can be used earlier. More than that, the increased cooperation on the development and integration of a collaborative cloud-based network requires growing levels of trust between partners.

Yet, the transformation of the entire supplier-base will not be possible all at once. As mentioned earlier, there are hardly any cases in which Procurement 4.0 has been introduced. A survey by Glas and Kleemann (2016) found out that the perceived mean preparation time before becoming an I 4.0 company, is 6,92 years. This is quite long and thus, it cannot be expected that all suppliers in the value chain could evolve into I 4.0 companies in a short period of time. To still make the supply/value chain smart, a company has to decide which partners they want to initiate the process of developing I 4.0 and Procurement 4.0 with. As Kleemann and Glas (2017) say, every connection of supplies to the P 4.0 system is "its own little project" (translated from German, p. 19), suggesting it is rather difficult to include suppliers onto the platform. Thus, as the initiator of the integration process, an organisation should carefully decide with whom to cooperate. To decide which supplier to start with, Kleemann and Glas suggest identifying which suppliers are most suitable. In addition to a digital orientation, the supplier should be chosen based on the significance for the digital change and how well suited the company thinks the supplier is (2017). The supplier then will become a strategic partner, because they help to enhance the growth prospects of the organisation and bring emphasis to future prospects (Batran et al., 2017). With the help of the successfully joined partner, the integration can be extended to more suppliers, to develop the previously described network.

The integration process as well as the actual cooperation on the cloud-based value chain platform, can be supported by the use of a communication network. Kleemann and Glas (2017), as well as Spath et al. (2013), are stating that through the increasing private use of Social Media, it becomes easier to incorporate those as a platform to facilitate and improve the coordination and control of processes. Dallasega, Rauch, and Linder (2018) share the opinion that such social media platforms "can efficiently improve collaboration among companies and help to decrease project delivery time […]" (p. 208). Given the above, a value chain integrating platform in combination with a social media-like network supports the collaboration work and promotes a faster integration.

There has been another vision described. By the usage of Industry 4.0-technologies in the manufacturing company i.e. additive manufacturing and smart, adoptive modular production systems, the way a buyer orders will see a different dimension. According to Kleemann and Glas (2017), a buyer will not order the products itself, but only a licence for replication from a supplier. With that licence and the previously mentioned technologies, it becomes possible for the buyer to produce needed parts, such as small amounts of spare parts, itself. That

would be beneficial, because the time for a newly ordered spare part would be eliminated and the downtime of a production machine can be kept low.

5. RELEVANT FACTORS IN THE FACILITATION OF INFORMATION FLOW BETWEEN BUYER AND SUPPLIER

To begin with – and as pointed out before – the collaboration with partners in the supply chain will turn to a platform-based system. Hence, there will be enormous amounts of data shared between all partners included in the network, eventually leading to a free flow of information. In the following part, this paper will identify, as well as discuss, factors that will be needed to take into consideration and summarises the most important aspects in Table 1.

Over all, one aspect that has been mentioned, is that the procurement function of a manufacturing company is often not taken into account, when deciding on I 4.0 developments within the company. Glas and Kleemann state Industry 4.0 would not be successful with an integration of Procurement 4.0 since it is P 4.0 is a "fundamental conceptual element of Industry 4.0" (p.58). Nonetheless, procurement creates the connection point which stands in contact with business partners and thus, can facilitate the process of transformation into an I 4.0 company. Without the integration of procurement into the digital strategy of the company, neither the development of P 4.0, nor the integration into a supplier network would be possible. As a matter of fact, P 4.0 is in the need for smart procurement technology, and thus needs to receive substantial investment. This way P 4.0 can help to develop I 4.0.

The next factor that can be identified is the technology since it can be seen as one of the most important aspects for the developments in I 4.0 and facilitation of digital communication and exchange of information between businesses. Every research paper on the topics of I 4.0 or P 4.0 have exemplified the technology advancements, some in more detail and some more general, such as Lasi et al. (2014), Monostori (2014), Porter and Heppelmann (2014), etc.. Nonetheless, it has been claimed that technologies, as they are, can currently not support the new evolving procurement. Therefore, focus should be led to the development of such (Kleemann & Glas, 2017). Also, they have argued that technology itself is not capable of solving the problems occurring in Procurement 4.0, e.g. sharing of highly sensitive data. In fact, technologies are the underlying base of the developments and a lack of it, or not advanced-enough technologies, will result, amongst others, in a non-functioning cloud-based networking system. Additionally, in P 4.0 autonomous order systems will take over a big part of the procurement functions and thus, eliminates some of the jobs in procurement.

Besides technology, another prominent factor regards collaboration which refers to the cooperation of several companies into the value chain in building an I 4.0 platform. The collaboration with other parties is crucial for the development of 4.0 and solves problems arising in this regard, and therefore, companies should have an open mind cooperatively work together with other partners (Batran et al., 2017). However, collaborating with other businesses requires a certain level of trust, which can be constructed through close partnerships and mutual support (Nyaga, Whipple, & Lynch, 2010). This becomes increasingly important especially because essential and sensitive company information and data need to be shared to make the kind of platform work, especially to an extent when information will flow freely. The trust factor and the hesitation to share data are discussed more often i.e. Batran et al. (2017), Tseng, Tan, Chiu, Chien, and Kuo (2018) and Kagermann (2013). This was stressed as an issue by the company representative of Wila. They admitted that as a company, they know that the sharing of information is crucial for the development of I 4.0 with its partners. However, companies are simply too reluctant as they want to retain their secrets and protect themselves. The representative even expressed that it is "not going to happen in this generation of smart Industry" that information can freely be shared with anyone. On the other hand, they also admitted that it would not be a problem with trusted companies. So, building trust and collaboration are so closely connected, they are combined into one aspect.

One aspect that eventually can improve the willingness of sharing information includes data regulations which would provide a common legal ground. In particular, data ownership and data security are in the centre of attention. According to (Kagermann, 2013), when industries are disrupted by new technologies, regulation often lags behind, which creates problems in their implementation. There are two sides to it: first, there are no defined policies on contracting, which is done by autonomous procurement systems. Then, it is uncertain who owns data if it is generated in cooperation with suppliers, as well as that it is questionable how the security of data on collaboration platforms can be ensured (Kleemann & Glas, 2017). There is always the risk of data fraud, security gaps and data theft, and so regulations are needed to minimise those. Overall, it will be important "to adopt a global approach to safety and security" (Kagermann, 2013, p. 47), since information flow does not stop at borders. Next to that, Kagermann (2013) suggests adjusting business models in a way that data is only exchanged in return of a form of payment. However, that concept would lead to the opposite of free flow of data. The company Wila indicated the issue of regulations as well. They focused even more on the topic of Intellectual Property rights, as they develop their own software. Due to the fact that data regulation and security are always burning topics, researchers are putting much emphasis on it. Given the just mentioned reasons, data regulations and security are another highly relevant aspect for platform-based sharing of information.

Just as regulations, standards can assist in making information flow in smart industry possible. It was mentioned by Kleemann and Glas (2017) that there is still a lack of suitable, standardised technology systems, that can be integrated and used by every actor. In fact, the contrary is the case. Almost all companies have their own solution which fits their needs, though is not compatible with the systems that their partners have in place. This way, the integration with supply chain partners will prove to be even more challenging, especially when it concerns very fast changing partners (Kleemann & Glas, 2017). Subsequently, standardisation of systems, processes and information is needed to facilitate integration, to collaborate in such a way that the supplier-network can quickly be extended. Adding to that, Ten Hompel and Henke (2014) point out that the standardisation of the physical material flow and supply chain processes is needed, too, as it will helps anticipate to future events (translated from German, p.619). The issue of standardisation has been covered several times in research so far, and throughout, was given great importance and assigned high necessity, e.g. Kleemann and Glas (2017), Wollschlaeger et al. (2017), Trappey, Trappey, Govindarajan, Sun, and Chuang (2016). The standards might raise problems, though. There are no International standards in place yet, which would complicate the cooperation with suppliers that are far from adopting a smart approach (Schröder, 2016) in other countries. Still, because standardisation of technologies is likely to have a positive influence on the integration of other

companies and a smooth process flow, it will be considered as highly relevant for the facilitation of P 4.0.

One more factor that should not be forgotten, regards the changing set of skills needed in the evolving procurement function. In contrast to e-procurement, procurement 4.0 does not require the manual input of data by employees. E.g. smart systems will provide support in decision-making through automatically analysed data, so analysts will not be needed anymore (Kleemann & Glas, 2017). However, though a number of activities will be taken over by automated, autonomous systems, there is still the need for skilled employees. After all, the focus of the skill-set needed has shifted to a stronger IT direction, requiring employees to have basic knowledge in the technologies implemented. Examples for new activities are that procurement specialists will have to develop and maintain processes which are then used to operate by autonomous systems; define and execute necessary IT-systems; define procurement variables such as conditions and limits for the ordering process, and they are responsible for monitoring and securing that processes can be realised; etc. Broadly said, new procurement employees will have to ensure the trouble-free operation of the procurement systems. Without that, the technological base would be useless.

Table 1: Relevant factors in Procurement 4.0

Factor	Importance
Management Support	Secure investments by including procurement into the digital strategy
Technology	Base of the revolution Need strong developments
Collaboration and trust	Reduce hesitation of trusting third parties Facilitate the exchange of information and data
Regulations	Establish a base for collaboration Focus on data ownership and security
Standardisation	Support the integration into the supplier platform
New Procurement skills	Essential for facilitating Procurement 4.0

6. CONCLUSION

It can be concluded that through the introduction of Industry 4.0, business functions will face changes as they adapt to the revolutionised situation. In this paper, the relationship between buyer and supplier has been investigated with regard to the Procurement 4.0 developments. Although it still cannot be fully predicted what impacts I 4.0 has on the procurement function, an approximation shows that the interconnectivity between companies will grow. This will most likely happen through the integration of suppliers into a cloud-based platform. The goal of such a platform is to enable the flow of data and information, so that smart data analytics – like artificial intelligence – can act as support for decision-making, as well as automate procurement functions to the extent that autonomous ordering is made possible. This will lead to more cost-, resource- and time efficiency, and so, possibly to a better performance of the business.

To ensure that the concept of such a platform will be successful, six factors have been identified. At first, the procurement department needs to secure the support of the management and integration into the digital strategy, to receive the necessary investments. Secondly, technology may seem like an obvious aspect, but it is essential to develop of the right technologies so that the networking process on a larger scale, so numerous suppliers, is enabled. Next, there are two aspects combined into one factor, as the hesitation of opening up to other parties was discussed. Collaboration and trust are determinants for the facilitation of the free flow of information. The lack of trust in other parties is still an issue, as admitted by a manufacturing company. The fourth identified factor describes the urgent need of regulation in regard to data. Ownership, safety, contracting by autonomous systems etc. need to find its way into P 4.0. This would moderate the fear of having sensitive data stolen in companies and likely decrease hesitation. As a fifth factor, standardisation can be assigned high relevance. Since there are no standards on technology, data or material flow in place yet, the integration into a shared network, hence cooperation, become rather difficult. Lastly, the procurement function as such will see changes in the skill-set needed. The work in procurement will become much more technical as employees will ensure that processes, taken over by autonomous systems, run smoothly.

Finally, the relationship between buyer and supplier is facing another major change. On one hand, technology will take over processes that have previously been done by employees and so reduce the human interaction. Though on the other side, it will strengthen the relationship with each other. This is way, trust and collaboration are essential for cooperation in an integrated supplier network with free information flow.

7. LIMITATIONS AND FUTURE RECOMMENDATIONS

One of the limitations of this research is the time frame in which this research was conducted, which was ten weeks. The formulation of the research question has changed several times, leading to an even shorter time frame in doing actual research.

This paper clearly discusses an area with little practical application, which has not been much applied by combining the opinions of different researchers into one picture. Based on that, it becomes visible that a lot needs to be done in practice. Subsequently, there is a lack of research on the introduction of industry 4.0 into different functions other than manufacturing and logistics, which will need to be filled.

More specifically, with regard to this research, the accuracy of factors, to facilitate the successful interaction between partners in a supply chain, will need further investigation. The factors are mostly based on the literature that has been reviewed and an interview with one company. Due to this, further research is needed to test the validity of those factors as there are possible intercorrelations between them. Though, to assess the factors, research should be conducted based on data gathered in companies working with procurement 4.0. As well, there is a need further research into possible other factors, that might influence the information exchange in I 4.0, as it is likely that this research did not point out every single one.

Lastly, due to the fact that Procurement 4.0 is such a newly researched area, there have not been many papers published. Therefore, this research was only based on a few well-explained

studies such as Kleemann and Glas (2017) and Glas and Kleemann (2016). Hopefully, in the future, more research will be conducted and more accurate results can be given.

8. ACKNOWLEDGEMENTS

I would like to give a special thank you to my supervisor Robbert-Jan Torn. First of all, thank you for awaking the interest in Industry 4.0 inside of me, and for a fantastic guidance throughout the process of preparing and writing this Bachelor Thesis, as well as for establishing Thesis-Thursday. Further, thank you to the second supervisor Dr. F. Schuberth for taking the time and responsibility to grade this thesis. Last but not least, I would like to give another special thank you to Dr. J.M. Jauregui Becker (Juan) for providing feedback on the work throughout the process of the research.

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