Industry 4.0 – Expectations of Purchasers

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ABSTRACT,

In the light of the increasing digitalization and globalization in business a new industrial revolution becomes evident. The upcoming industrial revolution will be the 4th disruptive innovation phase in history, named Industry 4.0. Due to the almost nonexistence of literature focusing on the ramifications of Industry 4.0 on purchasing, this thesis will focus on the expectations of purchasers on the effect of Industry 4.0 on purchasing. A series of interviews was conducted with purchasers to examine their expectations regarding industry 4.0 in purchasing. The qualitative data that was obtained through the interviews, was compared with the results of the pilot study 'Procurement 4.0'. The 12 points summarising the results of the pilot study were then used as a basis of comparison. The examination of the results revealed that industry 4.0 in purchasing is still in the early stages of its development, as only a minority have already implemented elements of industry 4.0 in purchasing. Furthermore, the interviewees predict a decrease in operative tasks, going hand in hand with a reduction of purchasing staff, due to operative tasks being autonomously automatized. Some of the purchasers think that there will be problems with senior purchasers having to adapt their working styles and getting used to new technologies. Moreover, the interviewees prognose a shift away from a price focus towards strategic partnerships with suppliers. Besides that, the results revealed that the interviewed purchasers expect many incremental innovations and developments, instead of few radical ones when industry 4.0 is implemented in purchasing. All in all, this research adds to the existing literature of industry 4.0 in regard to purchasing and can be seen as guideline for future research.

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1. EXPECTATIONS OF PURCHASERS REGARDING INDUSTRY 4.0 IN PURCHASING

The importance and impact of purchasing on company performance has been well researched since the early 1990s (Pearson & Gritzmacher, 1990, p. 91; Carr & Smeltzer, 1999, p. 57; Carr & Pearson, 2002, p. 1050; Chen et al., 2004, p. 1050; Úbeda et al., 2015, p. 1). Geissbauer et al. claim that due to the disruptive effects of Industry 4.0 companies will not only have to rethink the way their organizations work today, but also their entire (…) value proposition of procurement to their suppliers, customers, and internal process partners" (2016, p. 4). Therefore, purchasing will be subject to radical changes over the coming years. Currently the topic of Industry 4.0 is receiving a lot of attention across all types of media (Deutsche Presse-Agentur, 2018; Hartmann, 2018; Höpner, 2018). Industry 4.0, which is also known as the fourth industrial revolution (Marr, 2016), Industrial Internet (US), Internet of Things (Gilchrist, 2016, p. 1), Smart Manufacturing (Jacinto, 2014), 'Industrie du future' (France) and 'Made in China 2025' (Rojko, 2017, p. 78). Yet there is no universally accepted definition for Industry 4.0, but rather a collective term (Brettel, Friederichsen, Keller, & Rosenberg, 2014, p.43; Hofmann & Rüsch, 2017, p. 24; Lasi, Fettke, Kemper, Feld & Hoffmann, 2014, p. 240; Lu, 2017, p. 2; Wiesmüller, 2014, p. 197). Industry 4.0 has different characteristics, which are, but are not limited to: cyber-physical systems, smart machinery making autonomous decisions, one-off products (Kagermann, Helbig, Hellinger & Wahlster, 2013, p. 13), horizontal and vertical system integration, the cloud (cloud-based software and applications), big data and analytics, augmented reality, industrial internet of things, cybersecurity, additive manufacturing, simulation (Gerbert et. al., 2015), machine-to-machine communication (Sung, 2017, p.1), 3D printing and sensor technology (Batran et al., 2017, p. 15). As Drath and Horch (2014, p.56) point out, the fourth industrial revolution would be the first industrial revolution to announce itself before it has happened. All industrial revolutions have been characterized by: being started by disruptive technology and enabling small productivity gains at the beginning (Torn, Pulles & Schiele, 2018, p.3). Furthermore, it can be beneficial for corporate success to be among the "First Movers" or "Early Adopters" since companies are able to pre-empt scarce resources and seize technological leadership (Liebermann & Montgomery, 1988, pp. 41-45; Schilling, 2017, pp. 93-95).

The aim of this research is to investigate the expectations of purchasers regarding Industry 4.0 in purchasing. To accomplish this, 5 purchasers will be interviewed. The results of this study will be analysed and compared to the results of the pilot study "Procurement 4.0" by Pellengahr et al. (2016). The aims of this research lead to the following research question:

What are purchasers expecting of Industry 4.0 in purchasing?

The thesis will be structured as follows: Firstly, the historical background of the previous industrial revolutions will be assessed to highlight and illustrate the importance of the current developments. Afterwards the relevant Industry 4.0 and Procurement 4.0 literature will be analysed, with special attention to the Procurement 4.0 Pilot Study by Pellengahr et al. (2016). Subsequently the research design and methodology will be established. The results of the conducted interviews will be analysed and compared with the Procurement 4.0 pilot study.

Finally, a conclusion will be drawn, limitations and recommendations for future research will be made on the basis of the analysed literature and the results of the conducted interviews.

2. THEORETICAL FRAMEWORK OF THE PREVIOUS INDUSTRIAL REVOLUTIONS AND INDUSTRY 4.0 WITH A SPECIAL FOCUS ON PURCHASING

2.1 Looking back at the past industrial revolutions and the advancement from steam engines and mass production to autonomous robots and machine-to-machine communication

2.1.1 The first industrial revolution – From handcrafting to machine production

The first industrial revolution has its origin in Great Britain in the late 18th to early 19th century (Berg & Hudson, 1992, p. 24). The first type of steam engine was developed by Thomas Savery and it was patented July 25, 1698 (Dickinson, 2011, p. 20). Thomas Newcomen developed a more practical steam engine in 1712, which fixed some of the shortcomings of the Savery steam engine (Frenken & Nuovolari, 2004, p. 4). Later in 1769 James Watts started improving Newcomen's earlier design and invented the Watt's steam engine, which was patented in 1781 (Ayres, 1989, p. 13; Dixit, Hazarika & Davim, 2017, p. 30). Watt's steam engine consumed about one third of the fuel of the Newcome engine and was therefore widely used to run machines in factories (Ayres, 1989, p.13). Through the steam engine the factory system was made possible, which centralized the workforce and machines in one place (Landes, 2003, pp. 1-2). Overall the steam engine directly and indirectly increased the standard of living, as it allowed the more efficient manufacturing of goods and faster transportation on land and sea (Dixit, Hazarika & Davim, 2017, p. 30; Schiele, 2016, p. 15).

2.1.2 The second industrial revolution – Rise of electricity and electric motors

The second industrial revolution took place between 1870 and 1914 in industrialized countries like Great Britain, Germany, France and the United States of America (Kinghorn & Nye, 1996, pp. 1-2; Mokyr, 1998, p. 1). It was characterized by the introduction of the assembly line, electricity respectively electric engines, and mass production (Mokyr, 1998, pp. 2, 5 & 9). Areas with extensive technical advancements were: Steel, Chemicals, Electricity and Transportation (Mokyr, 1998, p. 2-7). In the field of steel, the possibility of cheap mass-produced steel opened up different prospective uses, as steel is more durable than iron in mechanical and other applications (Mokyr, 1998, p. 3). Important breakthroughs in chemistry were the discovery of synthetic dye in 1856 by William Henry Perkin (Hunger, 2007, pp. 1-2), the invention of the vulcanization process by Charles Goodyear in 1839 (Mokyr, 1998, p. 5) and the creation of the first synthetic plastic by Alexander Parkes in 1862 (Painter & Coleman, 2008, p. 8). Furthermore, with the invention of the first rotating electrical engine in May 1834 by Moritz Jacobi, continued research by other scientists and with the introduction of the electric DC motor, it became possible to have the exact amount of power in the production process where it was needed, resulting

in a change of how factories were designed and paving the way for mass production (Doppelbauer, 2013; Schiele, 2016, p. 15). Transportation saw the rise of the automobile, which was invented and patented by Karl Benz in 1886 (von Fersen, 2013, pp. 10-15) and ships made from steel, which were bigger, faster and more powerful than the preceding sailing boats (Mokyr, 1998, p. 7).

2.1.3 The third industrial revolution – Triumph of automation and digitalization

The third industrial revolution or information age started in the 1970s with the introduction of programmable logic controllers (PLC) (Brettel et al., 2017, p. 37). Another important development is the rise of the personal computer, with the MITS Altair being the first of its kind, yet being commercially unsuccessful (The Editors of Encyclopedia Britannica, 2017). It is notable that with every new computer generation performance improved, but prices remained stable (Hornstein, 1999, p. 2). Furthermore, while short term effects were not favourable for the poor, since the innovative technologies lead to profitable investment opportunities for the wealthy, in the long run everybody profited from the introduction of new technologies (Greenwood, 1997, p. 11). Moreover, the introduction of automation in business processes increased productivity and improved the quality of work life (Olson & Lucas, 1982, p. 846).

2.1.4 The fourth industrial revolution – Changes through cyber-physical systems

The fourth industrial revolution will be driven by the internet of things and cyber-physical-systems (Ramsauer, 2013, p. 7). It will focus on connecting the physical with the digital world to create cyber-physical-systems (Botthoff & Hartmann, 2015, p. V; Kagermann, Helbig, Hellinger & Wahlster, 2013, p. 13). These cyber-physical-systems will offer opportunities to visualize, use and record complex information (Botthoff & Hartmann, 2015, p. 10) and they will help companies to connect their production plants, logistical systems and products (Ramsauer, 2013, p. 7). Through machine-to-machine communication and autonomous decision making of machines, Industry 4.0 aims to improve production processes, raw material usage and logistics (Botthoff & Hartmann, 2015, p. V; Ramsauer, 2013, p.8). The fourth industrial revolution will build on the previous one by adapting the existing automation processes (Wee, Kelly, Cattel & Breunig, 2015, p. 14)

Due to the high degree of connectivity in production processes within Industry 4.0, a close coordination and cooperation with suppliers becomes even more imperative than today, due to the need for seamless and fast flow of materials exactly when they are needed, in the right quantity and quality (Hofmann & Rüsch, 2017, p. 24). As the procurement departments are in direct contact and connect with suppliers, the importance and influence of procurement in the light of Industry 4.0 cannot be denied.

2.2 Basis of Comparison: 12 points from the Pilot study Procurement 4.0

The 12 points from the pilot study 'Procurement 4.0' by Pellengahr et al. (2016) serves as a basis for comparison for the conducted interviews (see Table 1). The study was conducted by the Fraunhofer Institute for Material Flow and Logistics (IML) and the Federal Association of Materials Management, Purchasing and Logistics e. V. (BME). The point of the study was to recognize patterns, tendencies and solutions to initial problems and to utilize them to distinguish the principal fields of activity in guiding the change (Pellengahr et al., 2016, p. 9). Based on the summarized opinions of the surveyed experts, these 12 points were deducted from its results, to summarize its

outcome. In the following these 12 points will be highlighted and described.

2.2.1 Statement 1: Procurement is shrinking and operative procurement is becoming more autonomous in most areas.

It is possible to completely autonomize operative procurement processes, once this becomes a reality, the main concern for strategic procurement will be to monitor and analyse these processes (Pellengahr et al., 2016, p. 7).

2.2.2 Statement 2: The demands placed on and expectations of strategic procurement are growing and the demand for a higher value contribution is therefore increasing.

Purchaser will have to do more and more complicated work in the future, namely they will have to deal with the fact that firms are selling their customers a variety of different products, including services, that put pressure on purchasing specialists (Pellengahr et al., 2016, p.7).

2.2.3 Statement 3: In the future procurement will take on a completely different form and traditional purchasers will be a thing of the past.

Over the next couple of years purchaser will have to possess a multitude of talents: they will have to be able to develop and enhance procurement systems, as well as work as internal and external interface managers, and effectively becoming data analysts (Pellengahr et al., 2016, p.7).

2.2.4 Statement 4: Personal relationships will continue to be extremely important in Procurement 4.0.

Purchasing will be influenced even more by technology in the future and communication will more effortless, but nonetheless personal relationships with suppliers and internal customers will continue to play a critical role in procurement (Pellengahr et al., 2016, p. 7).

2.2.5 Statement 5: Procurement is not fully responsible for the implementation of Industry 4.0 but it does play an essential role.

The main task of implementing Industry 4.0 on company level falls to upper management, but purchasing needs to fulfil their responsibilities, as they are responsible for managing the interfaces with the company's suppliers (Pellengahr et al., 20016, p.7).

2.2.6 Statement 6: The changes taking place relate to all relevant dimension: technologies and systems, organisation and processes, management and people and also business models.

Due to the nature of Industry 4.0 of connecting different parts of the company even further, the changes of digitalisation cannot be seen as separate (Pellengahr et al., 2016, p.7).

2.2.7 Statement 7: Creating transparency is the most important requirement in order to be able to implement Industry 4.0.

The topic of Industry 4.0 and its implications still need to be made clearer so that the utilization of Industry 4.0 is uncomplicated (Pellengahr et al., 2016, p.7).

2.2.8 Statement 8: Big data and data processing technologies are key technologies involved in

digitalisation and play a decisive role, above all in connection with networking.

Because of Industry 4.0 communication between company internal stakeholders and communication within the supply chain is ameliorated, but also conflicts arise quicker (Pellengahr et al., 2016, p.7).

2.2.9 Statement 9: Procurement needs to adapt its own structure and processes to suit digitalisation.

Procurement has to digitalise its existing processes and procedures, through utilising big data and other forms, to be able to react in real-time and present important data, so it can concentrate on essential operations (Pellengahr et al., 2016, p.8).

2.2.10 Statement 10: Procurement needs to manage a procurement portfolio that has been partially modified and is becoming increasingly digitalised.

Because of digitalisation, purchasing departments will have to adapt their current processes and product portfolio, due to the need to procure new materials to manufacture new products (Pellengahr et al., 2016, p. 8).

2.2.11 Statement 11: Vertical and horizontal networking (by means of technologies) facilitates the transformation from a functional perspective to a process-based perspective – This opens up the possibility for the unrestricted digitalisation of procurement and the entire procurement portfolio.

The process-based-perspective is engendered through vertical and horizontal networking, which facilitates the usage of systems and technologies to allow for networking activities (Pellengahr et al., 2016, p.8). Networking is essential for the success of Industry 4.0, as stakeholders can only benefit from the improvements if they share it with others (Pellengahr et al., 2016, p.8).

2.2.12 Statement 12: Procurement is a driving force behind horizontal networking.

To fully utilize the advantages of Industry 4.0, procurement departments need to introduce technologies and innovations into a company, through horizontal networking (Pellengahr et al., 2016, p.8).

Statement number:	Summarized Statements from the Pilot study 'Procurement 4.0 by Pellengahr et al. (2017):
1.	Procurement is shrinking and operative procurement is becoming more autonomous in most areas.
2.	The demands placed on and expectations of strategic procurement are growing and the demand for a higher value contribution is therefore increasing.
3.	In the future procurement will take on a completely different form and traditional purchasers will be a thing of the past.
4.	Personal relationships will continue to be extremely important in Procurement 4.0.
5.	Procurement is not fully responsible for the implementation of Industry 4.0 but it does play an essential role.
6.	The changes taking place relate to all relevant dimension: technologies and systems, organisation and processes, management and people and also business models.
7. :	Creating transparency is the most important requirement in order to be able to implement Industry 4.0.
8.	Big data and data processing technologies are key technologies involved in digitalisation and play a decisive role, above all in connection with networking.
9.	Procurement needs to adapt its own structure and processes to suit digitalisation.
10.	Procurement needs to manage a procurement portfolio that has been partially modified and is becoming increasingly digitalised.
11.	Vertical and horizontal networking (by means of technologies) facilitates the transformation from a functional perspective to a process-based perspective – This opens up the possibility for the unrestricted digitalisation of procurement and the entire procurement portfolio.
12.	Procurement is a driving force behind horizontal networking

Table 1. Overview – Summarised statements of the results of the pilot study 'Procurement 4.0' by Pellengahr et al. (2016).

3. METHODOLOGY

The aim of this research was to investigate the expectations of purchasers regarding Industry 4.0. Qualitative research was conducted in the form of semi-structured interviews (Appendix 7.1, 7.2). Qualitative research was used as it is especially suited to understanding the experiences of the participants, the environment in which the participants operate and making new discoveries (Maxwell, 2012, p. 30). Literature on Industry 4.0 from a purchasing standpoint is almost non-existent when compared with other field such as manufacturing. Furthermore, the pilot study Procurement 4.0 by Pellengahr et al. (2016) was chosen as a basis of comparison due to its similar aim and being the only one with comparable results.

Five purchasers were interviewed, out of those five, two are working for the same company and were interviewed at the same time. The interviewed purchasers were all in leading positions of their purchasing departments except one who was a seasoned purchaser. Furthermore, the purchaser's companies' sizes range from 900 to 60.000 employees and are conducting their business in different industries. Three out of the five agreed to have their interviews recorded. Two interviews were done over the phone and the remaining three were held in person. All interviews except for one, which was held in English, were conducted in German. On average the interviews the interviews lasted 55 minutes, with the shortest interview lasting 15 minutes and the longest one lasting two hours. The data was collected through an interview guide containing eight questions (Appendix 8.1 & 8.2). Moreover, the interview questions were self-developed with the pilot study 'Procurement 4.0' by Pellengahr et al. (2016) and the conference paper by Torn, Pulles and Schiele (2018) serving as a guideline. The interview guide was structured to focus on Industry 4.0 elements within the companies in the first part and asking about the expectations of the interviewees regarding Industry 4.0 in purchasing in the second part. After the

interviews, the recordings or notes taken during the interviews were used to transcribe the interviews (see Appendix 9.3). The transcriptions were used to summarize the expressed opinions and predictions of the interviewees.

In the following the results of the five conducted interviews will be presented, summarized and analysed. The interviews are presented in randomized order and by using general terms, such as Purchaser A and Company A, the anonymity of the participants is ensured.

4. RESULTS AND ANALYSIS OF THE CONDUCTED INTERVIEWS

4.1 Purchaser A expects changing of people's mindset as one of the biggest challenges

4.1.1 Industry 4.0 is present in the company and in purchasing it is on the horizon

Purchaser A's company has elements of Industry 4.0 in their operations department to operate their machinery. Regarding purchasing, it is planned to set up a dedicated department, within the purchasing department, which entirely focuses on Industry 4.0 to have everything centralized in one place, especially the future activities.

4.1.2 Incremental changes in purchasing.

Purchaser A expects the implementation of Industry 4.0 to take several years in purchasing and in all relevant company wide areas. Furthermore, he thinks that purchasers will have to do less operational activities, such as drafting contracts and similar processes. Purchaser A believes that the reduction in work might result in a reduction of staff in low level positions in purchasing departments.

4.1.3 People will have to adapt to new working styles.

Purchaser A anticipates that Industry 4.0 will require a different mindset from people, because of the new and unusual way of working. Moreover, he expects that changing the mindsets of people will be a big, if not the biggest challenge as working styles and routines have developed over the years. As a consequence, Purchaser A assumes that seasoned purchasers or older purchasers will struggle with adjusting to an even further digitalised procurement.

4.1.4 Improved flow of information makes purchasers life's easier.

Purchaser A predicts that through implementing Industry 4.0 in purchasing, requirements for goods and services will be clearer. He is also certain that through Industry 4.0 forecasts will improve. As a result of these improvements he concludes that purchasing departments will be able to more easily make contracts and purchase orders, as they are informed in advance.

4.1.5 Important decisions still done by humans.

Purchaser A anticipates, that no matter what changes or new developments Industry 4.0 introduces to purchasing, there will still be purchaser on a strategic level, who make the final agreements and contracts with suppliers.

4.1.6 Basic tasks in purchasing carried out by machines.

Purchaser A presumes that through machines carrying out operational tasks, such as creating purchaser orders or doing the expediting, purchasing departments might see a decrease in staff numbers.

4.2 Purchaser B expects Industry 4.0 to connect interfaces of existing solutions

4.2.1 First elements of Industry 4.0 present in purchasing and planning in other areas.

Purchaser B's company has already implemented elements of Industry 4.0 with a selected number of suppliers. Currently there is automated price calculation through a system with market price indexes (such as raw materials or labour). So, in theory there is no need for negotiations or contact with the suppliers, as it is a digital form of setting the price for a service or good. All in all, there is no need for direct negotiations, after an agreement has been reached with the supplier on the systematic. In other departments there are possible scenarios of how Industry 4.0 could be usefully implemented, but Purchaser B is not sure whether there is anything implemented yet.

4.2.2 Industry 4.0's implementation will consume a lot of resources and will take some years.

Purchaser B anticipates that the implementation of Industry 4.0 will take several years, and it will require a lot of effort and energy.

4.2.2.1 Transforming analogue information into digital information.

Purchaser B thinks, that through a reduction of case handling and operative tasks (drafting documents, signing etc.) some jobs in purchasing departments might get lost. He also assumes that it will be challenging to transform analogue information into digital information, so it can be used within the newly developed or improved systems.

4.2.2.2 Reduced friction will be beneficial.

Once the implementation is successful, Purchaser B expects large savings through reduced friction and human errors, as well as less operational work, since they are already heavily using an enterprise resource planning (ERP) system in his purchasing department. He also believes that through improved market transparency and knowledge about suppliers, which is implemented into newly developed or improved systems, the results of tenders and procurement processes will improve.

4.2.3 Personal contact will continue to be one of the key elements of purchasing.

Purchaser B anticipates that personal contact will remain important, as final decisions will still be taken by humans. Furthermore, the internal relationships will continue to be the same, since the purchasing departments will still have to talk to their internal consumer or user before any process is started. After the technical requirements have been set the new or improved systems will be used to fulfil the internal consumer needs. Moreover, Purchaser B believes, that the contact with sales representatives will remain an important factor in purchasing, as the sales employees of the suppliers will continue to use their experience in selling their product.

4.2.4 No 'Big Bang', but rather many small changes and improvements.

Purchaser B thinks that there will be no radical break through, but rather many incremental developments on the basis of existing solutions, such as SAP, catalogues and electronic tendering platforms. Furthermore, he expects that the currently separate procurement systems will be interconnected in the future, so that interfaces disappear.

4.3 Purchaser C anticipates a reduction in purchasing staff and yet more work to be done

4.3.1 Industry 4.0 is used in operations, but not to a large extent in purchasing.

In the company of Purchaser C, elements of Industry 4.0, such as machines making almost fully autonomous decisions, are present in operations, but with a human as the last instance of control. Furthermore, in the supervision of certain elements computers are used, for example to monitor dangerous gases. If there is a malfunction or failure in the monitoring process, the computer automatically calls for a repair and service crew. Also, sensors are used to fully control (no human interaction) the movements of goods. Regarding purchasing, the current trends are not applicable, since the purchasing is project based and therefore no applicability for standardization. Yet there are some forms of Industry 4.0 in the purchasing department of Purchaser C, namely, machine-to-machine communication. Through the connection of different systems present in the company, purchasing is assisted with award proposals.

4.3.2 Automation will cause a decrease in purchasing employee numbers.

Purchaser C predicts that there will be a further reduction in purchasing staff. Through this reduction a greater deal of automation will be required or staff from other departments will have to handle the ordering of certain goods themselves, to manage the increasing workload, Purchaser C forecasts. Another major challenge Purchaser C expects, is data protection. Since procurement systems will be interconnected even further, data protection will be a vital and decisive matter in the near future.

4.3.3 How will Industry 4.0 cope with the loss of know-how because of demographic change?

Purchaser C anticipates that it will be problematic to forecast in obsolescence management with Industry 4.0 (some elements in their operations department are 30 years old), as they have to take into account how the spare parts supply is developing over the decades, what technical advancements will be made and how laws and regulations will develop. Moreover, Purchaser C expects that it will take a while for a market dominant system to arise. This is a factor for them, as the company, Purchaser C works for is medium-sized and they have to follow the trends of the large enterprises, he claims. He also thinks that one of the major challenges regarding Industry 4.0 will be demographic change, as with a lot of purchasing professionals retiring, considerable knowledge, expertise and experience gets lost.

4.3.4 Strategic partnership will be of increased importance and will benefit purchasing.

Purchaser C expects a larger focus on strategic partnerships, with a strong focal point for win-win solutions. As a result of this, he also expects less negotiations about prices and conditions. Furthermore, he anticipates a great deal of standardization and a shift from product focused procurement, towards a function focused one.

4.3.5 Purchasers will continue to make the final decisions.

According to Purchaser C humans will continue to have the final say in negotiations. He believes that since humans are setting the limits for any type of negotiations, machines can only operate within these boundaries set by humans. Furthermore, he is assertive that the psychological element in negotiations will continue to be of major importance, since humans can continue to negotiate outside of set parameters, which machines cannot.

He gives the example that during a negotiation you might include future deals and other similar types of elements, such as warranty, taking over product specific costs, etc., outside of set parameters.

4.3.6 No major changes in purchasing, except for technical and environmental developments, laws and regulations.

Purchaser C anticipates no ground-breaking changes in purchasing regarding Industry 4.0, except for environmental factors, changes in laws and regulations and new technical developments. Nonetheless he thinks that there will be no radical changes, but rather a step-by-step introduction of new elements.

4.4 Purchaser D expects a high degree of standardization across different areas of purchasing.

4.4.1 First elements of Industry 4.0 in purchasing and no real elements of Industry 4.0 in other departments yet.

In purchasing, Industry 4.0 elements are used in a supportive way to purchase C-parts. Two purchasing system are connected by a computer that autonomously makes orders after they have been cleared and are transformed from one system to the other. Furthermore, after the purchased goods have been marked as received, the payment is automatically made and only inspected on a point-by-point basis. Although no concrete plans for Industry 4.0 have been made, all relevant software used in different departments has been mapped, with special attention to software used in cross-departmental processes. Based on this map, the first thoughts are being made, where it is useful and where an implementation of Industry 4.0 elements would make a meaningful contribution to value creation.

4.4.2 Standards will play a crucial role.

Purchaser D anticipates a high degree of standardization from Industry 4.0 in purchasing. Firstly, he is expecting product group standards, with a superior view for each market. Secondly, he expects supplier standards, that include coherent or standardized supplier-master data, which can be used in different purchasing systems. Thirdly he expects process standards: regarding the search of products (similar to Google), the presentation of the search results with text and picture and an European Article Number (EAN) Code to clearly identify the picture, the selection of the product directly on screen with an easy transfer of data, inquiry of the selected product in different forms possible with a link to the nearest distribution partner. Moreover, he is hoping for further software developments to match the interface of purchasing software with private ones (similar to Amazon).

4.4.3 Without full implementation of Industry 3.0 an implementation of Industry 4.0 is impossible.

Purchaser D predicts that since many companies still have not fully implemented Industry 3.0, they cannot implement industry 4.0. Therefore, he expects that transforming analogue data and processes into digital one to be an important task. Purchaser D is also anticipating a clash between the old ways of thinking and doing things and new technologies and approaches that will be introduced by Industry 4.0. Furthermore, he expects a scarcity of IT resources, which will slow down the implementation of Industry 4.0, when the majority of companies will be trying to implement it. Moreover, he thinks that there will be human resource problems with acquiring or developing qualified purchasers, which are able to use the new software or tools, as they have to be trained today to use tomorrows products. He also believes that the digital connection with suppliers will take time,

as there are no standards on any level (world-wide, Europe-wide or nation-wide). As a result of the radical changes through Industry 4.0, Purchaser D anticipates an overexertion of old purchasers through the drastic changes in their work and work environment. Nonetheless he also expects an overexertion of the young purchaser due to the large number of interesting tasks on top of their daily ones. Therefore, Purchaser D believes that health care and resilience management will be key to ensure the well-being of purchasing employees. Additionally, he predicts that the costs following the implementation, such as fees or additional support, will cause problems. The purchaser who leads the software project will have to devote time of his workday to do support-tasks. Purchaser D also forecasts that in the future an outage of a single IT system in the chain will cause serious confusion and problems, because nobody is able to work anymore. These developments will require a new 24/7 level of service as smart AI or computers will be able to work day and night. Purchaser D predicts that fast network coverage for suppliers in rural regions will be problematic. In the field of service procurement processes, Purchaser D expects problems, since computers or machines will have problems, due to the lack of comparability of the service. Purchaser D also predicts that liability issues for system errors or failures will cause problems and will determine whether the implementation of Industry 4.0 in purchasing will be a success or failure. Additionally, he forecasts, that changes in laws and regulations will also cause problem, as software or computers will have to take these changes into account. Another obstacle Purchaser D expects is the issue of data protection. As a substantial amount of confidential data will be online sufficient data protection is eminent, yet impossible to guarantee.

4.4.4 Purchasing processes will be simplified and purchaser will be able to focus on strategic tasks.

Purchaser D thinks that purchasing is able to design its own internal and external processes for the future. He explains that if these processes or systems would resemble the websites that are privately used, such as Amazon, eBay or price comparison sites, the administrative effort or operative tasks would be greatly reduced. Furthermore, he expects that through the reduction in administrative efforts or operative tasks, such as choosing a product, selection of tenderers, tender preparation, offer creation, etc.) through automation, purchasers are able to focus on strategic tasks, like analysing product groups or evaluation of A-products or -services. Moreover, Purchaser D expects that due to new software developments or improvements, purchasers will be able to work from anywhere, as long as there is a stable and fast network connection.

4.4.5 Personal contact will remain an important part of purchasing.

Purchaser D expects that entrepreneurial thinking of purchasers, as well as the desire to continually improve and develop new products and services will continue to be of major importance. Furthermore, he anticipates that personal contact with suppliers and/or with internal customers for complex services or projects will continue to be an important part in purchasing. According to Purchaser D personal contact with all companies and suppliers, for designing the supply chain processes will continue to be crucial.

4.4.6 The focus will shift from price to interface solutions.

Purchaser D predicts that the focus in negotiations will shift away from price, towards interface solutions. Furthermore, he expects that market dominating companies, who offer Industry 4.0 solutions or software will be able to choose their clients, which

will make aiming for win-win deals and strategic partnerships even more important. He also anticipates that purchaser will have to develop from commodity group managers to supply-chain-managers, to directly develop into collaboration-managers. This will have to be done, he explains, in a constantly changing environment with short development cycles. Furthermore, he thinks, that artificial intelligence will assist with strategic decisions, but the learning period of the AI will be critical in ensuring trust in the recommendations of it. He also expects, that strategic partnerships and long-term commitments with strategic and bottleneck suppliers will be inevitable. Purchaser D also predicts that in risk analysis of supplier development and supplier evaluation the quality of data and data connection will increase in importance. Especially since system failures and errors will have major impacts on purchasing departments, but to compare this measurable and comparable standards are needed.

4.5 Purchaser E thinks that Industry 4.0 will be implemented where it is possible and useful, but humans will always be part of purchasing.

4.5.1 Industry 4.0 is used in operations, but not to a large extent in purchasing.

Industry 4.0 is used in many aspects in operations, for example it is used for transporting goods within the facilities and within operations. In purchasing there are no elements of Industry 4.0, since their purchasing efforts are project-based, with a low degree of standardization.

4.5.2 Through Industry 4.0 the workload will increase, while purchasing employee numbers will decrease.

Purchaser E also expects that through Industry 4.0 the amount of work will increase and although the workload increases, according to Purchaser E, the amount of purchasing employees will decrease.

4.5.3 Machines cannot do all tasks and always depend on what they have been taught.

Purchaser E thinks, that a machine or computer cannot do all tasks, only what is has been taught. Furthermore, he expects that computers or machines can never show empathy and detect the oppositions motivation in a negotiation. Computers only negotiate within their set boundaries, which they have been given by humans, he explains.

4.5.4 Less negotiations through strategic partnerships.

Purchaser E expects a bigger focus on procuring functions and not products. He explains that you will not be searching for a specific product, but rather the function of the product type. Through this focus on functions and also strategic partnerships, he predicts that there will be less negotiations, which in turn results in less negotiation work for purchasing departments.

4.5.5 Humans will remain an integral part of purchasing.

Purchaser E anticipates that human influence and contact will continue to play an important role, as humans can be empathetic and think creatively. He further explains, that computers or machines will be good for standardizing, simplifying or standardized products, but humans will always tell computers or machines their boundaries and limits.

4.5.6 Purchasing will depend on changes in laws and regulations, technical advancements and environmental factors.

Purchaser E predicts, that purchasing will have to deal with major changes in laws and regulation, technical developments and environmental factors. He expects, that Industry 4.0 will be implemented where it is possible and useful, but not at every cost.

4.6 All purchaser agree that personal contact will remain an integral part of purchasing.

The interviewed purchasers mutually agree that as a result of implementing Industry 4.0, there will be less operational work to be done in the future. Therefore, they also predict, that staff reductions in purchasing are likely. Moreover, most interviewees agree that purchasers will continue to take major strategic decisions and that through the reduction of administrative or operative tasks they will be able to mainly focus on strategic elements. Furthermore, the majority expects difficulties of existing purchasing staff with adapting to the new working styles and approaches. According to the interviewees, another important factor will be data protection and quality, since Industry 4.0 processes will rely heavily on it. Regarding the degree of change, the interviewed purchasers expect no 'Big Boom', but rather many small changes and developments Another mutual opinion of the interviewees is that strategic partnerships with suppliers will become more important, due to the stronger connection with suppliers through Industry 4.0.

5. DISCUSSION AND COMPARISON OF THE RESULTS WITH THE PILOT STUDY 'PROCUREMENT 4.0'.

5.1 The structure of the comparison

In the following the results from the interviews will be compared to the results from the pilot study 'Procurement 4.0' by Pellengahr et al. (2016) (see Table 2). Each one of the 12 points will be looked at and similarities and differences will be discussed. Elements that were discussed in the interviews, but that are not present in the pilot study, will be highlighted separately in the end.

5.2 Similarities and difference of the studies

Statement	Purchaser				
	A	B	C	D	E
1. Statement	✓	✓	✓	✓	✓
2. Statement	✓	✓	X	✓	X
3. Statement	✓	✓	X	✓	X
4. Statement	✓	✓	✓	✓	✓
5. Statement	X	X	X	X	X
6. Statement	✓	✓	✓	✓	✓
7. Statement	✓	X	X	✓	X
8. Statement	X	X	✓	✓	✓
9. Statement	✓	✓	X	✓	X
10. Statement	X	✓	X	✓	X
11. Statement	X	✓	✓	✓	✓
12. Statement	X	X	X	X	X

Table 2. Overview - Comparison of the Pilot study's statements with the results from the interviews.

5.2.1 Statement 1: Procurement is shrinking and operative procurement is becoming more autonomous in most areas.

Statement one is similar to the results that have been obtained through the conducted interviews. The interviewed purchaser also predict that operative and administrative tasks will not be done manually in the future. The study by Gottge and Menzel had similar findings, as their results show a clear tendency towards autonomous and automatized purchasing (2017, p. 105). Hence the interviewees also expect a reduction of employee numbers in purchasing departments. Again, this is also reflected in the study of Gottge and Menzel, as they see one of the biggest challenges in how to deal with the replacement of employees with machines (2017, p. 102). Furthermore, they also explain that due to the nature of the then autonomously automatized tasks, these changes will mainly affect lower qualified workers (Gottge and Menzel, 2017, p. 102).

5.2.2 Statement 2: The demands placed on and expectations of strategic procurement are growing and the demand for a higher value contribution is therefore increasing.

This statement is also reflected in the conducted interviews. The majority of the interviewed purchaser expect that through the predicted reduction of administrative or operative tasks, purchaser will focus on strategic tasks and decisions. Purchaser D also mentioned that according to his opinion purchasers will have to continue to strive for improvement of processes and production, which in turn will improve value creation. Moreover, Purchaser C and E indicated that in their opinion processes will only be autonomously automatized where it is possible and improves value creation. Purchaser B also expects reduced friction and human errors through implementing Industry 4.0 elements in operative tasks, which also leads to improved value creation. These findings are supported by a study on Purchasing 4.0 in the automotive industry by Gottge and Menzel (2017, p. 104), which also concluded that purchasers will mainly focus on strategic and analytical tasks in the future.

5.2.3 Statement 3: In the future procurement will take on a completely different form and traditional purchasers will be a thing of the past.

Again, this statement is mostly mirrored by the obtained results from the interviews. The interviewees predominantly agree that through implementing Industry 4.0 in purchasing new processes and approaches will be replacing the old processes and work approaches. Also, the interviewed purchasers highlighted that experienced purchasers are likely to struggle with these new processes, due to new technology involved. Additionally, Purchaser D also brought up that he anticipates a clash between old purchasers wanting to stick to their old and proven ways of purchasing and the younger ones who are open to new innovations and processes.

5.2.4 Statement 4: Personal relationships will continue to be extremely important in Procurement 4.0

Statement four is also backed by the findings from the conducted interviews. All interviewees jointly predict that personal contact will still play a key role in purchasing, once Industry 4.0 has been implemented. They expect this for different reasons, some think that computers or machinery may be good for standardizing or simplifying, but lack empathy, creativity and to think outside their limits. Others believe that purchaser and sales people alike, have acquired certain psychological skills in buying or selling their products, which they will continue to use in negotiations. It

was also mentioned that the personal contact with internal customers will continue to be crucial in discussing the specifics and technical requirements for the procurement.

5.2.5 Statement 5: Procurement is not fully responsible for the implementation of Industry 4.0 but it does play an essential role.

None of the interviewees mentioned something about the responsibilities regarding the implementation of Industry 4.0. Purchaser A believes that implementing Industry 4.0 will take some years and that the larger a company is, the longer it will take. Purchaser B also predicts that the implementation of industry 4.0 will take several years and that it will require a lot of time and energy. Purchaser D mentioned a somewhat similar statement to the one from the pilot study. He believes that purchasing will benefit from designing its own future processes.

5.2.6 Statement 6: The changes taking place relate to all relevant dimension: technologies and systems, organisation and processes, management and people and also business models.

Almost all elements of this statement have been collectively mentioned as being influenced by Industry 4.0 by interviewees, except for business models and management. Purchaser A also mentioned that there will be a dedicated Industry 4.0 department within their purchasing department.

5.2.7 Statement 7: Creating transparency is the most important requirement in order to be able to implement Industry 4.0

Statement seven is also somewhat replicated by the results of the conducted interviews, however only by a minority. Purchasers A and D mentioned that there is no clear universal definition or common vision regarding Industry 4.0 and therefore there are a lot of phantasies.

5.2.8 Statement 8: Big data and data processing technologies are key technologies involved in digitalisation and play a decisive role, above all in connection with networking

Again, this statement is partially reflected in the results of the interviews. The majority of the interviewed purchaser expect that data quality, data protection and data processing will play a key role in Industry 4.0, as the future systems or software is going to depend on the data they have been provided with. These findings correspond with Geissbauer, Weissbarth and Wetzstein (2016, p. 8), who also predict a strong reliance on data utilization.

5.2.9 Statement 9: Procurement needs to adapt its own structure and processes to suit digitalisation.

The majority of the interviewees gave similar answers to the statement. Purchaser B and D both believe that one of the biggest challenges will be the transformation of analogue data or processes into fully digital ones. Purchaser D also mentioned that according to his expectations, companies will have to fully implement Industry 3.0 to implement Industry 4.0. Purchaser A also explained that Industry 4.0 will require a different mindset from purchaser, as the ways of working will be different from today.

5.2.10 Statement 10: Procurement needs to manage a procurement portfolio that has been partially modified and is becoming increasingly digitalised.

As it was mentioned in the previous point Purchasers B and D both believe that current processes and data of purchasing will need to be digitalized to be suitable for usage within Industry 4.0. However only a minority of the interviewees mentioned similar aspects.

5.2.11 Statement 11: Vertical and horizontal networking (by means of technologies) facilitates the transformation from a functional perspective to a process-based perspective – This opens up the possibility for the unrestricted digitalisation of procurement and the entire procurement portfolio.

Again, this statement is partially reflected by the answers of the interviewees. Most of the interviewed purchasers view close relationships or strategic partnership as key in the future, because through Industry 4.0. supplying and buying companies will become much more interconnected.

5.2.12 Statement 12: Procurement is a driving force behind horizontal networking.

None of the interviewees mentioned anything similar during the conducted interviews.

5.2.13 Aspects not covered by the summarized results from the pilot study.

As it was mentioned by the 12 points, it is expected that Industry 4.0 will change almost every aspect of purchasing. In the following, aspects that were mentioned by the interviewees, but that are not covered by the 12 summarised points from the pilot study by Pellengahr et al. (2016) are highlighted. The highlighted aspects were not necessarily mentioned by a majority of the interviewees, but their nature was deemed important enough to be acknowledged. Firstly, the interviewees believe that rather than large radical change, Industry 4.0 will bring about many small incremental changes over a longer time period. Also, some of the interviewees pointed out that they expect older experienced purchaser to have problems with adapting to new technologies. It was also mentioned that Industry 4.0 will likely have to deal with the effects of demographic change and the loss of know-how because of retiring purchaser. The topic of dealing with elderly purchasers was also considered in the study by Gottge and Menzel (2017, p. 106), where they recommend training for elderly purchasers to be able to work in a highly digitalised setting. The topic of human resource troubles is also reflected by Geissbauer et al., as they predict a need to develop new types of purchasers and different types of job profiles (2016, p. 9). Although it has been somewhat touched by the summarized statements from the pilot study, almost all of the interviewed purchasers said that strategic partnerships will be inevitable in the future, due to interconnection of the procurement systems.

6. CONCLUSION: PURCHASER EXPECT A REDUCTION OF OPERATIONAL WORK, WHICH IN TURN WILL BENEFIT STRATEGIC TASKS.

6.1 Industry 4.0 will change purchasing as we know it today.

The aim of this study was to investigate the expectations of purchasers regarding Industry 4.0 in purchasing. The majority of the summarized results from the pilot study 'Procurement 4.0' by Pellengahr et al. (2016) have been reflected by the results from the conducted interviews. Industry 4.0 in purchasing is far from being the predominant form. In the interviewed companies only, a minority had implemented some elements of Industry 4.0. Overall, the interviewed purchasers expect no radical changes, but many smaller incremental ones which will change the face of purchasing and will introduce new or improved purchasing

systems. Yet they predict that this process of implementing Industry 4.0 will take several years and will consume a lot of energy and money. The interviewees also jointly agreed that the amount of purchasing department employees is likely to decrease, as many operative tasks will be autonomously automatized. One of the aspects that the pilot study did not highlight, is the prediction of the interviewees that there will a conflict or challenge between the old purchasing processes and the purchasers, who are used to them, and the new innovative processes, which Industry 4.0 will introduce to purchasing. Another not clearly expressed aspect is that the interviewed purchasers expect a stronger focus on strategic partnerships and long-term relationships with suppliers, which will be inevitable, due to the strong the interconnection of the buying and supplying companies in the future. A major aspect that was not mentioned in the pilot study by Pellengahr et al. (2016), is the question of how purchasing and Industry 4.0 will deal with demographic change and the loss of know from retiring purchasers and to what extent this know-how can be conserved by using Industry 4.0 elements.

6.2 Limitations and future research

Due to the lack of (positive) responses from companies (55 companies contacted, 18 negative responses, 33 times no answer or reaction, only 4 positive answers with one answer being from two purchaser) and therefore small sample size, this study can be seen as a hint towards further research or confirmation for the results of the pilot study 'Procurement 4.0' by Pellengahr et al. (2016). Furthermore, as the majority of the interviewed purchasers work for companies based in Germany the conducted research can only be seen as guidance for what to expect from similar countries. Furthermore, the interview where two purchasers were interviewed at the same time might have limited reliability, as the two purchasers likely influenced each other's statements. Moreover, the answers of the interviewees differ in their degree of extensiveness, some of the interviewed purchasers elaborated their answers quite extensively, while others kept their responses rather short. This likely impacted the results of this research.

Future research should focus on broadening the results of this study by including a larger sample size. Moreover, separate studies should be conducted with an international sample to compare whether differences can be discovered on an international level regarding the expectations for Industry 4.0 in purchasing. Another interesting aspect could be the comparison of different industries and company sizes regarding Industry 4.0 in purchasing. Furthermore, future research should focus on discovering actual practical applications of Industry 4.0.

7. ACKNOWLEDGMENTS

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9. APPENDIX

9.1 Interview questions in German

N.	Frage:
1.	Gibt es in ihrer Beschaffungsabteilung bereits Industrie 4.0 Elemente?
2.	Haben sie Industrie 4.0 Pläne oder Strategien für die Beschaffung? Wenn ja, wann werden diese umgesetzt?
3.	Gibt es in ihrem Unternehmen bereits Elemente von Industrie 4.0 in anderen Abteilungen?
4.	Was sind ihre Erwartungen an Industrie 4.0?
5.	Welche Probleme sehen sie vor dem Hintergrund von Industrie 4.0 auf die Beschaffung zukommen?
6.	Welche Vorteile sehen sie vor dem Hintergrund von Industrie 4.0 für die Beschaffung?
7.	Was wird sich in Bezug auf Industrie 4.0 im Einkauf ihrer Meinung nach nicht verändern? (Oder glauben sie, dass sich alles verändern wird?)
8.	Was wird ihrer Meinung nach die größte Veränderung in Bezug auf Industrie 4.0 im Einkauf sein?

9.2 Interview questions in English

no.	Question:
1.	Does the purchasing department of your company already employ elements of Industry 4.0?
2.	Does your company have an Industry 4.0 strategy or planning for Purchasing? If so when do you plan to implement it?
3.	Does your company have elements of Industry 4.0 present in other departments?
4.	What are your expectations regarding Industry 4.0?
5.	What challenges do you see for Purchasing regarding Industry 4.0?
6.	What benefits do you see for Purchasing regarding Industry 4.0?
7.	What do you think will remain unchanged, if anything, in Purchasing regarding industry 4.0?
8.	What do you think will be the biggest change in Purchasing regarding Industry 4.0?

9.3 Interview transcriptions
Removed due to confidential information.