

Procurement 4.0: factors influencing the digitisation of procurement and supply chains

Digitisation of
procurement
and supply
chains

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Abstract

Purpose – While digitisation is a key driver of the fourth industrial revolution (Industry 4.0); organisations have different approaches to deal with this topic to get a clearer picture of the opportunities and challenges concerning the digital transformation. The purpose of this paper is to identify the impact of digitisation on procurement and its role within the area of supply chain management. The research will also explore potential barriers to digitising procurement and supply chains and ways to overcome them. Finally, the significance of potential enabling technologies to the digitisation will also be examined.

Design/methodology/approach – A quantitative approach utilising an online survey was used to collect the primary data for this study. Data were collected from 414 participants directly involved with procurement or related business functions and work for different organisations in different industries. The survey included eight items about the impact of digitisation on organisational performance in the area of procurement and supply chains; ten items related to key barriers to digitisation of organisations and ways to overcome them; and seven items about enabling technologies to leverage procurement procedures and processes digitisation. All of these items utilised the Likert five-point level of agreement scale.

Findings – The findings indicate that digitisation of procurement process can yield several benefits including: supporting daily business and administrative tasks, supporting complex decision-making processes, procurement will become more focussed on strategic decisions and activities, procurement will become a strategic interface to support organisational efficiency, effectiveness, and profitability, and supporting the creation of new business models, products, and services. The authors were also able to confirm that there are barriers to digitising procurement process and supply chains and such barriers found in existing procedures, processes, capacities, and capabilities. Finally, the significance of a number of enabling technologies to the digitisation process was revealed.

Originality/value – To the best of the authors' knowledge, this is the first study of its kind with participants located world-wide. Industry 4.0 as a topic had been explored within different business areas and functions but very limited research specifically explored potential impact, barriers, and enabling technologies of procurement 4.0. The results can be beneficial for organisations already implemented Industry 4.0 or planning to do so. The study can also benefit academic scholars interested in the researched topic, business professionals, organisations within different sectors, and any other party interested in understanding more the concept of procurement 4.0.

Keywords Information technology, Supply chain management, Operations management, Performance management, Procurement, Industry 4.0

Paper type Research paper

1. Introduction

Considering a fast growing business environment across several borders and continents being forced by changing customer behaviours and requirements on the one hand and increasing competitive pressure on the other hand organisations are part of “Hybrid supply chain networks” as mentioned by Porter and Heppelmann (2014) which are getting more and more determined by “Internet-of-Things”, “Big Data”, and “Artificial Intelligence”. In recent times organisations are faced with a radical change because the global interconnectivity and exchange of data and information in real-time enable organisations to create new business models and concepts within their area of operation on the one hand, and on the other hand, an increasing competition, also deriving from new market entries, force organisations to increase their potential of innovation to maintain



competitiveness within the new created business models and concepts (Downes and Nunes, 2014). The disruptive and fast changing business discipline “digitisation” is on the top management-level agenda of organisations, research institutes, politics, as well as non-profit organisations. Within the future possibilities of information technologies and electronics in the 1970s (Industry 3.0) the industrial revolution is continuing with a fast pace and the actual evolution of “Industry 4.0” is still in progress. Due to the rapid progress, it is possible to state that the life cycle of industrial ages is getting shorter which requires organisations and stakeholders to put their potential for innovation and supply chain strategies on a new level to achieve competitive advantages (Schrauf and Bertram, 2016). One organisational function and supply chain activity which plays a significant role in the “digital age” is the field of procurement that is the main focus of this research study. Porter (1998) categorise the organisational activities for value creation into primary and supporting activities, “procurement” is one of the support activities. In this context, it is evaluated to which extent the function, discipline, and activity of procurement can change to be a more critical and strategic interface within the area of supply chain management and to support organisational efficiency, effectiveness, and profitability within a long-term perspective.

According to Bucy *et al.* (2016) and Zhong *et al.* (2016), the actual global digital transformation of organisations is driven by “Big Data” with the perspective to put organisational profitability and competitiveness on a new level. Therefore, organisations make use of “Artificial Intelligence” in supply chain ecosystems which in combination with human behaviour will create a new degree of intelligence, innovation, and collaboration. Considering the list of keywords “digitisation”, “procurement”, and “supply chain” organisations face a quite new field of concepts and methods as well as challenges and opportunities for their area of operation. The combination of white papers, future scenarios, and practical implementation is a “playground” for organisations to test future manufacturing concepts requiring downstream and upstream flows within the supply chain system (Brabazon, 2016). Therefore, the research problem describes a global issue and by considering the global supply chain systems there is an effect towards all supply chain parties and stakeholders. However, it is necessary to state that the influence of digitisation towards organisations is at a higher level in developed countries, due to reasons like infrastructure, access, capacity, and human capital (Katz, 2015).

The aim of the research is to analyse the actual influence of digitisation towards organisations and especially to bring the challenges and opportunities of digitisation in context with strategic procurement initiatives. Digitisation can play a leverage role to align existing sourcing strategies as well as to design new sourcing strategies to achieve the overall organisational goals of long-term growth, profitability, and competitive advantage. This aim links to the actual, or rather changing, role of procurement departments in organisations and the leverage potential towards the entire supply chain. In this context, new business models may occur and procurement needs to extend its support function to enable the organisation to act as a pioneer or early adaptor rather than being “just” a fast follower (Johnson and Flynn, 2015). The study attempts to answer the following three main research questions:

- RQ1. What is the impact of digitisation on organisational performance in the field of procurement (e.g. sourcing strategies and buyer-supplier relationships)?
- RQ2. What are the key barriers to digitising organisations and how to overcome them?
- RQ3. Which technologies (e.g. mobile solutions, cloud, enterprise resource planning (ERP), etc.) are required to leverage the potential of digitisation (with the focus on procurement procedures and processes)?

These three main research questions cover three main aspects of future organisational performance: first, the possibilities of digitisation in the field of procurement and areas of implementation. Second, the existing barriers based on a broader organisational perspective and solutions to overcome them, and, third, the required technologies and systems to make use of digitisation as a supporting activity in the field of procurement. This paper consists of five main sections. Section 1 provides an introduction about the explored topic, research motivation, and the main research questions. Section 2 reviews relevant literature on supply chain management and digitisation, procurement and digitisation, and procurement as critical factor of success for the digital transformation. Section 3 describes the used research methodology, including instrument development, sample and data collection, participants profile, data analysis methods, and instrument reliability and validity testing. Section 4 presents data analysis and the study results. The final section discusses the conclusions, implications of the findings, and limitations and future research.

2. Literature review

2.1 Supply chain management and digitisation

Raz (2008) points-out organisational activities within the past years to overcome these upcoming challenges by optimising internal procedures and processes. However, organisations have to implement and live the concept of supply chain management to expand their competitive advantage on the one hand as well as to increase their supply chain surplus on the other hand. In this context Sengupta (2013) and Deloitte (2014) name “Artificial Intelligence”, “Big Data”, “Industry 4.0”, and “Digitisation” as organisational fields of action to focus on within the next years. In addition, Wu *et al.* (2015) are covering the research field of “smart supply chain management” and the opportunities of technological developments to reduce overall costs and increase efficiency. Within a basic introduction Wu *et al.* (2015) force their research towards the topic of smart supply chain management by highlighting the actual viewpoint due comparing several resources and perspectives covered within the complex field of research. According to IBM (2009, cited by Ross, 2016) the future supply chain consists of the three technology-based drivers instrumented, interconnected, and intelligent further reviewed in detail in the following sections.

First, instrumented is referred to transaction processes that will be totally automated and managed by, e.g., sensor technologies, radio frequency identification (RFID), global positioning systems, etc., to increase visibility, reduce risks and costs, and overcome complexity (IBM, 2009). The automation of processes will be driven by “Artificial Intelligence” and “Big Data” as highlighted by Zhong *et al.* (2016) mutually supporting the requirement for sensor technologies as hardware on the one hand as well as software on the other hand to collect, control, and process the enormous amount of available data.

Second, interconnected is linked to internet technologies and beyond the direct collaboration of supply chain partners by including real-time market developments, e.g., to include customer feedback from social media activities and share, monitor, and manage follow-up activities and decisions in real time (IBM, 2009). The concept of interconnectivity is supported by Kumar *et al.* (2016) who outline the change in supply chain design due to the influence of integrative technologies like, e.g., “Big Data”, “Internet-of-Things”, etc., and the opportunities for organisations to create synergies due to the combination of “normal” production and “customer specific” production (e.g. due to additive manufacturing).

Third, intelligent is related to simulations of supply chain events and supported by technologies it is possible to create various scenarios in advance depending on future situations that result in a more efficient and effective supply chain control and the possibility to evaluate and eliminate risks before they occur (IBM, 2009). Okada *et al.* (2015) support the approach of simulation and supply chain models with the advantage of having a possibility to outline various possible upcoming scenarios and their effect towards

operations level (e.g. production, warehouse, etc.) as well as towards the strategic level (e.g. supply chain network, enterprise management, etc.).

These three technology-based drivers of the future supply chain are directly linked to or rather supported by the topic of digitisation to transform supply chains to completely integrated ecosystems with full transparent interfaces. Schrauf and Bertram (2016) summarise the evolution of the supply chain and point out the significance of the future supply chain as enabler and success factor for organisation in the future digital age. Furthermore Schrauf and Bertram (2016, p. 12) highlights “[...] integrated planning and execution, logistics visibility, Procurement 4.0, smart warehousing, efficient spare parts management, autonomous and B2C logistics, prescriptive supply chain analytics, and smart supply chain enablers [...]” as main areas for technological improvements and fields of innovation.

Vendrell-Herrero *et al.* (2017) do also highlight the existing technological developments in the field of digitisation as a general introduction as well as the influence of trends in the field of digital technologies towards the change in supply chain management. Within the general introduction the authors consider the trend of product dematerialisation and the effect towards organisations in the entire supply chain. They point out that the existing supply chain model will change within a future perspective with regards to functions, responsibilities, and stakeholders also driven by the increase of digitisation and its opportunities within the next decades supported by the outlined future trends of Sengupta (2013).

The increasing interest in digitisation and leverage of visibility within the supply chain forces organisations to finally align social responsible supply chain management towards their business model and strategy and the exchange as well as real-time access to information will increase the level of trust within the buyer-supplier relationship (Hoejmose *et al.*, 2013). Therefore and as supported by Handfield (2016) “response velocity” based on real-time supply chain transparency will be a future capability for organisations to achieve competitive advantage which requires to stay at the cutting edge of technologies and developments on the one hand as well as to make use of “Big Data” deriving from supply chain interfaces on the other hand. Ketchen *et al.* (2014, p. 169) highlight “[...] co-opetition, less permeable exit barriers, demand for value creation, and pooling knowledge and skills across the system [...]” as challenges as well as opportunities for organisations to set-up modern “supply chain ecosystems”. These are necessary to achieve an increase in transparency, innovation, and intelligence to force the digital transformation within an organisation and its responsive and resilient “supply chain ecosystem” (Schrauf and Bertram, 2016).

2.2 Procurement and digitisation

According to Philippart *et al.* (2005) the main advantage of e-sourcing is the fact that the traditional process is supported by a system which collects all information and activities and therefore creates a “one-to-one” communication between buyer and supplier. One digital solution as highlighted by Schmock *et al.* (2007) is the collection of information on a digital platform which can be accessed, shared, and processed in the most transparent way and in real-time with all supply chain parties to create a “many-to-many” communication. Based on the fact that products and services procured within an organisation can have a share on organisational expenses up to 80 per cent highlight the importance for organisations to drive their procurement departments for innovation and contribution towards the value chain (Day, 2002). Examples according to Van Weele (2009) are the definition of optimal stock levels at supplier’s and buyer’s warehouse, reduce overall capital commitment, reduce price level due to leverage innovation, or increase supply chain intelligence due to buyer-supplier relationships and alliances.

Giunipero and Brand (1996) point out the changing role or rather function of “procurement” within the “supply chain” based on a literature review and a typology of supply chain management. On the basis of a research study and with regard to the

definition of supply chain management as an organisational wide concept, Giunipero and Brand (1996) put procurement into a particular role within the entire supply chain by highlighting the potentials especially with regard to the interfaces towards customers and suppliers. Based on this definition the authors differentiate between “logistics” and “supply chain management” in a clear and strict way and put supply chain management towards an organisational strategy enabler. In this context the role of procurement is seen from a corporate point of view and its increasing importance for an organisation to reduce costs and increase competitiveness and profitability mutually which is supported by Johnson and Flynn (2015) on the micro-level perspective. To have procurement act as a strategic interface is also funded by Hoejmose *et al.* (2013) who highlight the importance of trust and transparency as key drivers for long-term success in buyer-supplier relationship.

Buyer-supplier relationships are set-up with the common goal to create win-win situations. Furthermore, these win-win situations can result in strategic partnerships to, e.g., force product developments based on the core competences, know-how, and capabilities from both organisations (Trent, 2007). With regard to collaboration, Sengupta (2013) highlights “Artificial Intelligence” as a future trend driving supply chain activities to certain extend of automation. In this case, the role of procurement as downstream interface between internal and external processes needs to operate with technologies on the latest edge to create innovative buyer-supplier relationships within a long-term perspective.

2.3 Procurement as critical factor of success for the digital transformation

Geissbauer *et al.* (2016) highlight the actual state of the art of the interaction of “procurement” and “digitisation” as well as outlining a future framework based on challenges and requirements. Driven by widespread buzzwords, Geissbauer *et al.* (2016) categorise the existing terminologies in their introduction and summarise them under the most common term of “purchasing 4.0”. The authors concentrate on the digital effect and possibilities of procurement in the field of supply chain management and the opportunities of an organisation within the next years. The future perspective is linked to requirements which are actually known as well as being further evaluated within the progress in the research topic of digitisation. Regardless of organisational size and field of industry the upcoming digital innovations will be a factor of disruption of procedures and processes being in place and well established within common supply chain models. This is supported by the research study of Berger (2016) CPO Agenda 2016 highlighting “Industry 4.0” as a new challenge and relevant field which must be managed by the chief procurement officer.

At the sole of this challenge are according to Khodadadi *et al.* (2016) “Big Data” and “Big Data analytics” as driver of the “Internet-of-Things” to support the digital transformation within an organisation. Haddud *et al.* (2016) highlight RFID, sensors, networks, and cloud computing as the key technologies for the “Internet-of-Things”. Furthermore, the authors state common standards for the transfer of information and communication within the “Internet-of-Things” are indispensable to make use of the potential within a global perspective. As mentioned before and as supported by Ketchen *et al.* (2014), these challenges will be the future factor of success for the definition of streamlined supply chain ecosystems to increase overall productivity by optimising internal and external supply chain processes and interfaces as stated by Zolnowski *et al.* (2016). In this context, Mantey (2015) set the responsibility of procurement to foster the development of common information infrastructures to create transparency, traceability, and agility within the increasing amount of information and data to support the creation of innovative and intelligent supply chain ecosystems. Related to this increasing collaboration and data-driven transactions the factors of “security” and “trust” still maintain a major role as it can be seen within the next two paragraphs.

First, Stephens and Valverde (2013) point out in their research study the growing importance of security in the field of procurement and supply chain management, especially

with regard to a number of virtual information flows and automated transactions. Barron *et al.* (2016) highlight cybersecurity in the supply chain overall and possible risks for organisations in cases of a malevolent attack. Therefore, it is essential to extend the developments of security and related security systems within the supply chain based on a common approach by including all supply chain parties and create common solutions and systems to secure the future common supply chain ecosystems against external violence (Johnson, 2013).

Second, deriving from the new interconnected and automated supply chain ecosystems the matter of trust plays a vital and important role in the entire ecosystem. Within “traditional” buyer-supplier relationships Keith *et al.* (2016) highlight trust as a powerful factor based on the interactions between both parties as well as external influence factors. Considering supply chain ecosystems, the factor of trust must be maintained mutually between more than two parties, which will challenge organisations in their traditional behaviour and require a change in organisational culture (Harshak *et al.*, 2013).

Stepping back in time and with regard to Kraljic’s portfolio purchasing model (Kraljic, 1983) the classification of suppliers and their impact towards (buyers) organisational profit and supply risk will change within a future perspective. This change takes place because suppliers who will collaborate in the field of digital sourcing and processes will be more important for the organisation while mutually the supply risk can be reduced due to a more transparent flow of information and warning systems at an early stage (Gelderman and van Weele, 2005). Also Kraljic is aware that the model needs to be adjusted according to changing conditions and points-out the required adjustments from his perspective in an interview by stating “[...] with the benefit of 25 years’ hindsight the importance of trust in long-term relationships with suppliers. You need [trust] to create win-win” (Kraljic, 2008 cited by Keith *et al.*, 2016, p. 28). Hughes and Ertel (2016) link the relevance of Kraljic’s model towards the actual development in the field of digitisation and define a new “procurement paradigm” which needs to be applied by organisation to stay at the competitive edge by making use of its procurement function in a more innovative and strategic way. At the core is the task of achieving a maximum total value from suppliers by leveraging assets, capacities, and capabilities from suppliers to support the own organisation with regard to innovation, value, and strategy. This requires to automate (or outsource) operational activities and concentrate on strategic activities and initiatives.

3. Research methodology

3.1 Instrument development

The chosen research design of “constructionism” has the clear approach to collect the different “facts” and “truths” and set them in relation to the daily business life to point out that the different viewpoints are important and relevant to force such a topic of strategic importance within the organisation. In this case there are various methodologies available and considering the before-mentioned model from Easterby-Smith *et al.* (2012) the “narrative method” fits best to the approach. “Narrative methods” are a more common label for research designs combining once more the elements of “ontology” and “epistemology”. With regard to the applied research the author is more detached because information are gathered within a research questionnaire and the author is not engaged in the further development of stories as he is without an influence towards the persons. However, according to Barkin (2010) it should not be limited to the “narrative model”.

The survey research questionnaire is set-up to cover three aspects of digitisation with the focus on procurement to collect an opinion towards its influence on supply chain management and the organisational performance overall. In the beginning, the general background and experience of the survey participant are collected. Based on this information, it is possible to categorise the answers in an appropriate way and determine

fields of action subsequently. The differentiation in the job field and job level is important to separate between the field of operations in a first step and the internal job level on the other hand to get a better understanding of the different points of view. The different fields of industry are listed to get a broader understanding of the perspective towards digitisation and the importance within the different industries. However, this information is collected additional and does not have an influence towards the original aim and objective. Nevertheless, this first intention can be used to outline potential fields of research within a future perspective. Finally, the location is collected to include the geographical perspective as well as to receive a feedback of the importance of the topic within the different areas.

The main research survey is categorised into three sections and guided by three key questions focussing on different aspects and areas in the interrelationship of digitisation, procurement, and supply chain management. The three key questions or rather the different paragraphs can be answered with the select options of “strongly disagree”, “disagree”, “neutral”, “agree”, and “strongly agree”. This kind of research design is known as “matrix question” or as the “Likert scale”. The different statements are written in a positive form which is also known as “acquiescence” (Brace, 2008). The first construct consists of eight statements and the main theme of this construct focusses on the relation between digitisation and procurement and the different statements target the influence of “Artificial Intelligence”, “Big Data”, and “Internet-of-Things” towards the procurement function. The participants respond to these statements from a general perspective and should not be limited to their actual position, job, or organisation. Based on these collected responses, it is possible to analyse the impact of digitisation on organisational performance, in particular the perspective of the different people being directly involved in the daily business. The second construct consists of ten statements and focusses on the main barriers organisations may face as a result of the digital transformation and includes: the organisational structure and culture, organisational environment, leadership style, and employee itself. The participants would answer these statements based on their personal point of view, experiences, and actual business environment. The responses to these survey questions will assist with identifying main barriers to digitisation and provide a first general indication for organisations to pay more attention to their progress of digital transformation. The third construct consists of seven statements and focusses on the tools and technologies that are required to leverage the potential of digitisation and the statements include different tools for communication, collaboration, and support. The participant should answer these statements from a general perspective and should not be limited to its actual position, job, or organisation.

3.2 Sample and data collection

In total, data were collected from 414 participants who were operating in the field of procurement or other business functions. Considering procurement in particular, this includes buyers, strategic buyers, and purchasing managers who are responsible for the implementation of supplier and material group management strategies as well as dispatcher, logistics planner, and logistics managers being familiar with procurement procedures and processes and their operational execution. Even due to the author’s actual location in Europe, the survey is not limited to a specific location, even if most participants will be located in high developed countries. Furthermore, the survey is not limited to a particular industry and based on the results it is assumed to analyse the employee’s opinion towards the research topic as well as to outline the changing role of organisational units (in especially procurement) within the influence of digitisation. Within the research survey, it is possible to select the industry sector the participants are actually working for to create a kind of industry cluster subsequently (Fowler, 2010).

3.3 Profile of participants

The profile of participants in this study is illustrated in Table I. In total, 14 per cent of the participants are younger than 30 years and 14.5 per cent were 50 years or older. The age group 30-39 years is represented by 38.6 per cent and the age group of 40-49 is represented by 32.6 per cent. Most of the participants have a postgraduate degree 51.2 per cent or an undergraduate degree 24.2 per cent. Furthermore, 13 per cent completed MBA, or PhD programme and 10.9 per cent of the participants had a college level degree. While 59 per cent of the participants are working in the job fields of strategic procurement-38.6 per cent and operative procurement 20.8 per cent and 40.3 per cent of the participants work in other job fields. Furthermore, 10.9 per cent of the participants had less than five years of professional work experience, 22.9 per cent had 5-10, 23.7 per cent had between 11 and 15, and 42.5 per cent had more than 15 years of professional experience.

Question	Frequency (<i>n</i> = 414)	Percentage (%)
<i>Age group (years)</i>		
Less than 30	58	14
30-39	160	38.6
40-49	135	32.6
More than 50	60	14.5
<i>Years of professional experience</i>		
Below 5	45	10.9
5-10	95	22.9
11-15	98	23.7
More than 15	176	42.5
<i>Education level</i>		
College level	45	10.9
Undergraduate/Bachelor	100	24.2
Postgraduate/Masters	212	51.2
PhD/MBA	56	13.5
<i>Job field</i>		
Operative procurement (e.g. logistics, dispatcher)	86	20.8
Strategic procurement (e.g. strategic buyer)	160	38.6
Other	167	40.3
<i>Industry</i>		
Aerospace, automotive, industrial manufacturing	117	28.7
Banking, finance	34	8.2
Chemicals, pharmaceuticals	13	3.1
Services	70	16.9
Transport, logistics	34	8.2
Other	144	34.8
<i>Job level</i>		
Employee level	121	29.2
Lower management level (e.g. team leader)	86	20.8
Middle management level (e.g. department director)	131	31.6
Executive management level (C-level)	76	18.4
<i>Geographical location</i>		
Europe	173	41.7
Africa	89	23.9
Asia-Pacific	36	8.6
Middle East	53	12.8
Americas	63	15.2

Table I.
Profile of participants

A total of 28.3 per cent of the participants work in the field of aerospace, automotive and industrial manufacturing, 8.2 per cent in banking and finance, 3 per cent in chemicals and pharmaceuticals, 16.9 per cent in services, 8.2 per cent in transport and logistics, and 34.8 per cent specify other fields of industry. Also, 29.2 per cent of the participants worked at an employee level, 20.8 per cent worked for positions at lower management level (e.g. team leader), 31.6 per cent were at middle management levels (e.g. department director), and 18.4 per cent of the participants had executive management level (C-level) job levels. Finally, the different locations are categorised according to the geographical region to get a more common understanding and general perspective. As shown in Table I, the participants are located as follows: 41.7 per cent in Europe, 23.9 per cent in Africa, 8.6 per cent in Asia-Pacific, 12.8 per cent in Middle East, and 15.2 per cent in America.

3.4 Data analysis methods

The collected data for this research were analysed using the IBM statistical package for the social sciences version 21. Because the used survey was newly designed specifically for this study; the reliability and validity of this used data collection tool were examined through the use of Cronbach's α values to examine the consistency and reliability of each of the three main used constructs. Also, descriptive analyses were conducted to calculate frequency means and percentages for each item within the three constructs that used the five-point Likert level of agreement scale. Finally, the standard deviation per question was calculated to determine the range of values or the variance of values. The standard deviation is a measure of how far in terms or units are all the responses located on both sides of the mean. The lower the standard deviation is, the closer to the mean the respondents' scores are, and thus, the answers are more consistent among the respondents for a certain position (Valverde and Saadé, 2015).

3.5 Reliability test of research instrument

Devellis (1991) and Hinkin (1995) define reliability as an indicator for measuring the homogeneity of the scale items in the same construct. Such measurement reflects how well the observed scores are related to the true provided scores (Lo and Yeung, 2006). Cronbach's α analysis was also used to examine the consistency and reliability of the used three constructs within the survey. As shown in Table II, Cronbach's α coefficient value for the impact of digitisation on organisational performance (procurement and supply chains) construct was 0.671. The second construct exploring potential barriers to digitisation and ways to overcome them had a Cronbach's α value of 0.888. While the third construct about required technologies to leverage digitisation had a value of 0.715. Rivard and Huff (1988) suggest that Cronbach's values exceeding α coefficient of 0.7 thresholds provide reliability evidence for internal consistency of the measurement scales. Two of the used three constructs had α coefficient values more than 0.7. However, and because the used survey was new and only designed for the purpose of this study, the third construct

Construct	No. of items	Mean	Item mean ranges	SD range	Cronbach's α
Impact of digitisation on organisational performance (procurement and supply chains)	8	3.93	3.15-4.36	0.695-1.026	0.671
Barriers to digitising organisations and ways to overcome them	10	2.98	2.68-3.34	1.022-1.172	0.888
Required technologies to leverage digitisation	7	3.88	3.32-4.14	0.717-1.027	0.715

Note: $n = 414$

Table II. Summary of findings in Cronbach's α reliability test analysis

that had a coefficient value of 0.671 should also be considered reliable. Lower thresholds are sometimes used in the literature (Santos, 1999) and for new instruments, construct with a reliability value as low as 0.5 is also acceptable (O'Leary-Kelly and Vokurka, 1998). Because the closer to 1 the coefficient values are, the more reliable the construct becomes (Cohen *et al.*, 2003), it can be concluded that the used three constructs in the survey instrument be considered as very reliable research tools.

4. Analysis and results

4.1 *Impact of digitisation on organisational performance (procurement and supply chains)*

The used construct to examine the impact of digitisation on organisational performance consists of eight items. The participants were asked to respond to these eight items using a five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree". The eight items were; Artificial Intelligence will be able to support my daily business and decrease operative activities; Artificial Intelligence will take over decision-making processes; Big Data within the organisational environment will be collected, analysed, and processed within the procurement function; Internet-of-Things will support the creation of full transparency within the supply chain ecosystem; transparency and traceability within the supply chain ecosystem will strengthen buyer-supplier relationships and level of trust; procurement function will be a strategic interface to support organisational efficiency, effectiveness, and profitability; procurement function will transform to a strategic and innovative network node and support the creation of new business models, products, and services; and people and "face-to-face" meeting will remain important to build-up trust and relationships. The standard deviation values for these eight items ranged from 0.695 to 1.026 and this indicates that the participants' responses were closer to the mean value and there were no outliers.

The three most supported statements were: people and "face-to-face" meeting will remain important to build-up trust and relationships (mean = 4.36); procurement function will be a strategic interface to support organisational efficiency, effectiveness, and profitability (mean = 4.20); and transparency and traceability within the supply chain ecosystem will strengthen buyer-supplier relationships and level of trust (mean = 4.12). While the three least supported statements were; Artificial Intelligence will take over decision-making processes (mean = 3.14); Internet-of-Things will support the creation of full transparency within the supply chain ecosystem (mean = 3.79); and procurement function will transform to a strategic and innovative network node and support the creation of new business models, products, and services (3.86).

Results shown in Table III indicate that Artificial Intelligence, Big Data, and Internet-of-Things are core elements with regard to procurement to automatise operative activities and create space for more strategic initiatives driven by human. Furthermore, the collection, analysis, and processing of data will be a key element for the creation of transparency and traceability within a supply chain ecosystem. In addition, the participants agree that an increase in transparency and traceability will strengthen buyer-supplier relationships and the level of trust. According to the participants, the procurement function will be a strategic interface to support organisational efficiency, effectiveness, and profitability due to its internal and external interfaces. This will enable the function of procurement within a future perspective to leverage its network interfaces and its transformation to a strategic and innovative network node to support the organisation in strategic decisions like, for example the creation of new business models, products, and services. Furthermore and even if digitisation changes the personal and business behaviour the participants point out that people will remain driving the business and personal "face-to-face" meetings and contact will continue to be a success factor to build-up trust and relationships.

Items	Mean	Strongly disagree	Disagree (Per cent)	Neutral	Agree	Strongly agree	SD
Artificial Intelligence will be able to support my daily business and decrease operative activities	4.03	2.2	5.6	10.9	49.5	31.9	0.920
Artificial Intelligence will take over decision making processes	3.14	4.8	24.4	30	33.3	7.5	1.026
Big Data within the organisational environment will be collected, analysed, and processed within the procurement function	3.92	1.2	4.3	14.7	60.6	18.6	0.783
Internet-of-Things will support the creation of full transparency within the supply chain ecosystem	3.79	1.2	4.8	22	56.8	14.7	0.795
Transparency and traceability within the supply chain ecosystem will strengthen buyer-supplier relationships and level of trust	4.12	1.2	4.8	22	56.8	14.7	0.844
Procurement function will be a strategic interface to support organisational efficiency, effectiveness, and profitability	4.20	1.2	4.8	22	56.8	14.7	0.695
Procurement function will transform to a strategic and innovative network node and support the creation of new business models, products, and services	3.86	1.2	4.8	22	56.8	14.7	0.799
People and “face-to-face” meeting will remain important to build-up trust and relationships	4.36	1.2	4.8	22	56.8	14.7	0.874

Table III. Participants' perception of the impact of digitisation on organisational performance (procurement and supply chains)

4.2 Barriers to digitising organisations and ways to overcome them

The used construct to examine potential barriers to digitising organisations and ways to overcome them consists of ten items including; existing infrastructure within my organisation can handle the digital transformation; existing job functions, roles, and descriptions can be transferred to the new role of procurement; leadership management within my organisation supports “creative freedom” for creativity and innovation; suppliers within my organisation are already included in the process of digital transformation; the communication structure within my organisation is lean and flexible; my organisation wants to implement digitisation and has no uncertainties and fears; my organisation has a risk management tool in place concerning the digital transformation; my organisation has a clear digital strategy; employees within my organisation have enough resources and capacities for the digital transformation; and employees within my organisation have the appropriate capabilities for the digital transformation. The standard deviation values for these ten items ranged from 1.022 to 1.172.

The three top supported items were: leadership management within my organisation supports “creative freedom” for creativity and innovation (mean = 3.34); existing job functions, roles, and descriptions can be transferred to the new role of procurement (mean = 3.21); and existing infrastructure within my organisation can handle the digital transformation (mean = 3.13). While the three top least supported items were: employees within my organisation have enough resources and capacities for the digital transformation (mean = 2.68); my organisation has a clear digital strategy (mean = 2.84); and my organisation wants to implement digitisation and has no uncertainties and fears (mean = 2.85).

Results shown in Table IV indicate that at first sight it is visible that the statements are answered in a very balanced way while some have more tendency to “agree” and some to “disagree”. Within the first three statements the participants moreover agree that the existing

Table IV.
Participants' perception of barriers to digitising organisations and ways to overcome them

Items	Mean	Strongly disagree	Disagree (Per cent)	Neutral	Agree	Strongly agree	SD
Existing infrastructure within my organisation can handle the digital transformation	3.13	6.3	29	19.6	34.8	10.1	1.132
Existing job functions, roles, and descriptions can be transferred to the new role of procurement	3.21	3.9	24.6	24.6	38.9	7.2	1.022
Leadership management within my organisation supports "creative freedom" for creativity and innovation	3.34	3.9	24.6	24.6	38.9	7.2	1.036
Suppliers within my organisation are already included in the process of digital transformation	2.99	5.3	33.1	23.2	31.9	5.6	1.048
The communication structure within my organisation is lean and flexible	3.07	6.3	23.9	32.4	29.7	7.0	1.036
My organisation wants to implement digitisation and has no uncertainties and fears	2.85	10.1	28.3	33.6	21.7	6.0	1.064
My organisation has a risk management tool in place concerning the digital transformation	2.91	9.7	30.0	25.6	27.8	6.3	1.104
My organisation has a clear digital strategy	2.84	9.7	30.0	25.6	27.8	6.3	1.121
Employees within my organisation have enough resources and capacities for the digital transformation	2.68	15.7	32.4	23.9	23.7	4.1	1.121
Employees within my organisation have the appropriate capabilities for the digital transformation	2.73	19.1	24.6	24.4	27.8	3.9	1.172

infrastructure, the existing job functions, as well as the existing leadership style can handle the digital transformation and organisations are ready for this big step. However, many participants are neutral as well as disagree which leads to the fact that organisations overall are not ready for this big step and have even not realised the potential as well as threats deriving from an increase in digitisation. This is also reflected by the participants' answers regarding the involvement of external parties, e.g., suppliers, and the existing internal communication structure. One-third of the participants disagreed to the statement that their organisations have appropriate communication structures and also disagreed with the statement that their suppliers are included into the process. Therefore, organisations have to evaluate their existing procedures and processes and align them to compete for the digital transformation.

Considering the organisation itself most participants highlight that their organisation is not ready for digitisation due to three main points. First, not all organisations have understood the revolutionary impact of digitisation so far because supply chain concepts and related risk management tools are not aligned to digital processes. Second, most of the participants highlight a missing digital strategy of their organisation to get a clear picture of the impact for every single department based on the overall organisational vision and mission. Third, employees within the organisation do not have the appropriate resources, capacities, as well as capabilities for the digital transformation.

4.3 Required technologies to leverage digitisation

The used construct to explore potential required technologies to leverage digitisation had seven items as follows: procurement platforms based on "many-to-many" communication will simplify my daily business; mobile applications, cloud solutions, and cloud-based ERP solutions will enable me to work with a full remote access; a common user interface

(for platforms and applications) will enable me to work more efficient and effective; social media platforms will be a helpful tool for internal and external communication and collaboration; RFID and smart sensors will increase the transparency and traceability of processes; cybersecurity requires a cross-functional approach and must be developed and forced by all supply chain stakeholder; and predictive analytical tools and algorithms will automate and speed-up transactions and processes. The standard deviation values for these seven items ranged from 0.717 to 1.027 and this indicates that the participants' responses were closer to the mean value and there were no outliers.

The three top supported items were: cybersecurity requires a cross-functional approach and must be developed and forced by all supply chain stakeholder (mean = 4.15); mobile applications, cloud solutions, and cloud-based ERP solutions will enable me to work with a full remote access (mean = 4.10); and a common user interface (for platforms and applications) will enable me to work more efficient and effective (mean = 4.06). While the least supported three items were: social media platforms will be a helpful tool for internal and external communication and collaboration (mean = 3.32); procurement platforms based on “many-to-many” communication will simplify my daily business (mean = 3.70); and RFID and smart sensors will increase the transparency and traceability of processes (mean = 3.90).

Results shown in Table V indicate that at a glance it is visible that the majority of all participants agree or strongly agree to the different statements. Concerning communication tools, most participants agree that platforms, remote access, and common user interfaces are key factors to increase efficiency and effectiveness on the one hand as well as to simplify tasks and daily business on the other hand. However, the communication channel of social media is answered with a very neutral perspective that could require some more time and experiences to have the full picture. Furthermore an important and leverage factor for the digital transformation is the RFID technology as well as smart sensors to support supply chain transparency and traceability. In addition, the combination of predictive analytical tools and algorithms will automate and speed-up transactions and processes to leverage the

Items	Mean	Strongly disagree	Disagree	Neutral (Per cent)	Agree	Strongly agree	SD
Procurement platforms based on “many-to-many” communication will simplify my daily business	3.70	1.0	6.8	24.6	56.5	10.9	0.79
Mobile applications, cloud solutions, and cloud-based ERP solutions will enable me to work with a full remote access	4.10	1.2	3.6	12.1	50.5	32.6	0.832
A common user interface (for platforms and applications) will enable me to work more efficient and effective	4.06	1.0	1.7	11.8	61.1	24.4	0.717
Social media platforms will be a helpful tool for internal and external communication and collaboration	3.32	5.1	16.9	29.0	39.4	9.7	1.027
Radio frequency identification and smart sensors will increase the transparency and traceability of processes	3.90	0.7	3.6	27.1	42.5	26.1	0.856
Cybersecurity requires a cross-functional approach and must be developed and forced by all supply chain stakeholder	4.15	0.7	3.6	27.1	42.5	26.1	0.749
Predictive analytical tools and algorithms will automate and speed-up transactions and processes	3.99	1.0	2.4	17.1	55.1	24.2	0.774

Table V. Participants' perception of required technologies to leverage digitisation

digital transformation from the process point of view. Finally, the participants agree that the issue of cybersecurity needs to be considered in a cross-functional approach by including all supply chain parties determine potential weak leaks and define preventive measures to ensure operation of a highly connected supply chain ecosystem.

5. Conclusions

5.1 *Digitisation and procurement*

Artificial Intelligence and Big Data are key drivers for the digital transformation of organisations to put its profitability and competitiveness on a new level. Within supply chain ecosystems the flow of information and therefore deriving data is the critical factor for organisational success or failure (Bucy *et al.*, 2016; Zhong *et al.*, 2016). The importance of Artificial Intelligence is supported by the survey results in the way of support function for the daily business and administrative tasks to free time for strategic activities. Furthermore, Artificial Intelligence can make use of Big Data to support complex decision-making processes by analysing the huge amount of data nearly in real time and highlight the most appropriate possibilities. While procurement will be more focussed on strategic decisions and activities (Chick and Handfield, 2014), it is essential to have the appropriate information within the organisational environment. According to the survey results, the role of procurement will be extended to collect, analyse, and process these data within the organisation and its internal and external environment and to become a strategic interface to support organisational efficiency, effectiveness, and profitability. Furthermore, the survey highlights the potential for procurement to be a strategic and innovative network node within the supply chain ecosystem to support the creation of new business models, products, and services. Therefore, it is also necessary to built-up long-term buyer-supplier relationship which according to Hoejmose *et al.* (2013) is supported by trust and transparency. In this context, the survey results point out the positive effect of the Internet-of-Things supporting the creation of full transparency within the supply chain ecosystem. In addition the increase in transparency and traceability will strengthen the before-mentioned buyer-supplier relationship and level of trust according to the survey results. Furthermore, the survey results highlight the importance of people and “face-to-face” meetings in the before-mentioned context of trust and transparency as base for a long-term buyer-supplier relationship.

5.2 *Digitisation and barriers*

The influence of digitisation towards an organisation as well as the digital transformation within the organisation itself has an impact towards existing procedures, processes, capacities, and capabilities (Katz, 2015). Therefore, organisations, managers, and employees are faced with several challenges and organisations have to provide an appropriate business environment to overcome these barriers by considering the different internal and external stakeholders. Hence, common processes are required to ensure a transparent flow of information, goods, and cash (Jacobs and Chase, 2014). According to the survey, organisations have to consider the existing procedures and processes from a system point of view as well as the current communication tools and channels to determine areas of improvement to handle the digital transformation. Furthermore, the new role of procurement within the supply chain ecosystem requires the definition of new tasks, roles, and responsibilities for organisational disciplines as well as employees (McKean, 2014). The survey results reflect that organisations are aware of these requirements but did not define these new roles within their organisational structure so far. However, and as a survey result organisations have to determine their digital strategy first and derive the appropriate actions in a second step. Due to the fact that employees are directly involved in the daily business they will experience the impact of the digital transformation at an early stage (Johnson and Flynn, 2015). According to the survey results, employees do not have the required resources and capacities as well as do not have the right capabilities to support the

digital transformation. This requires organisations to provide training on the one hand as well as to hire employees who already have the necessary capabilities for the new tasks, roles, and responsibilities. In addition, organisations have to consider their leadership management as an essential function and need to define a common mind-set and attitude towards this digital transformation.

5.3 Digitisation and technologies

The digital transformation will result in new technologies and software concepts that are required to handle the digital transformation as well as to stay at the cutting edge of technological developments. Busch (2016) highlights procurement platforms for “end-to-end” collaboration to leverage speed, creativity, innovation, and intelligence. Considering the survey results the procurement platform based on “many-to-many” communication is seen as an essential tool for organisations to speed-up transactions and leverage the before-mentioned potentials. Furthermore, and considering the communications tools the survey results point out to implement, e.g., cloud-based solutions with a standard user interface to enable an entirely remote access to increase efficiency and effectiveness. The real-time information flow requires the appropriate sensor technologies to monitor the single product as well as to enable the product to control itself to ensure an ideal material flow (Jonsson and Holmstroem, 2016). In this case, RFID technology and smart sensors play an important role for organisations to support transparency and traceability on the one hand and to leverage the potential of digitisation on the other hand to its full degree. Furthermore, the survey results highlight the support function of predictive analytical tools and algorithms to automate and speed-up transactions and processes. Due to the increasing amount of virtual information flows and automated transactions the importance of cybersecurity is rapidly increasing (Barron *et al.*, 2016). The survey results point out the importance to manage this issue based on a cross-functional approach including all supply chain parties to define appropriate solutions and systems to ensure the security of the common supply chain ecosystems against external violence.

5.4 Research recommendations

5.4.1 Employee level. As mentioned above employees are at the sole of organisational procedures and processes and therefore very close to the digital transformation. On the one hand employees will be affected by this transformation with regard to a change in the working processes and on the other hand employees have the chance to be part of a successful transformation by identifying areas for improvement. Therefore, employees should be open minded for the entire fourth industrial revolution and should support the opportunities instead of fearing the risks. Based on the survey results, it can be stated that employees are partly undecided based on the micro-level perspective which technologies can leverage the digital transformation, however, on the macro-level perspective the employees understand and highlight the importance of digitisation as success factor for the organisational future.

5.4.2 Management level. The digital transformation and increasing global connectivity with cross-functional teams summon the management to create a working environment that enables to free the potential of creativity and innovation. On the one hand managers have to guide employees through the process of the digital transformation while on the other hand it is essential to create space for employees to accomplish this change process to ensure a sustainable long-term success. Therefore, managers and leaders need to build trust and reliability in a first step to create a safe environment where employees can also free their fears and concerns regarding the change process. Furthermore, managers have to identify the bottlenecks and challenges on the macro-level perspective and define appropriate actions to overcome them as well as to ensure an efficient and effective business operation within the entire organisation.

5.4.3 Organisational level. Within an increasing global competition and access to similar resources and capabilities, organisations are faced with an extreme situation in the fourth industrial revolution. On the one hand organisations have to align their core business activities to increase profitability and competitive advantage while on the other hand external potential of innovation and capabilities are necessary to accomplish the digital transformation successfully. As most important point and survey result, organisations have to define their core competences and areas of business activities in a first step and to define their vision and mission based on a clear digital strategy. This requires the exit of non-profitable business activities and moreover to judge if mergers and acquisitions activities are necessary to extend the core business, leverage new market possibilities, and remain competitive.

5.5 Research theoretical and practical contribution

Re-considering the procurement stage model by Johnson and Flynn (2015) digitisation will have an important impact towards procurement and leverage the efficiency and effectiveness of “many-to-many” communication via shared platforms. Bearing in mind the survey results, technologies like Artificial Intelligence, Big Data, and Internet-of-Things enable organisations to automate and optimise their procurement stage model being actual in place to support the organisational digital transformation. Therefore, organisations should implement internal test environments to experiment with internal processes in real and extend the lessons learned towards the supply chain ecosystem. Re-considering the value chain model by M. E. Porter, the organisational role of procurement is an activity supporting the primary activities (e.g. operations, marketing, service, etc.) (Porter, 1998). Furthermore, Porter (1980) and Novack and Simco (1991, cited by Quesada *et al.*, 2010) point out the importance of procurement to leverage the level of performance and collaboration between the supply chain parties. Taken the survey results into account it can be stated that this existing theoretical framework will remain in its basic functional approach while the function of procurement will change to a more strategic and innovative role. Furthermore, procurement as strategic network node within a supply chain ecosystem enables organisations to control the increasing amount of data as well as to link different procurement functions to different organisations to create an intelligent master supply chain ecosystem.

5.6 Limitations and future research

The research includes and reflects a general overview of the impact of digitisation towards procurement and the role within the area of supply chain management as well as first conclusions and recommendations based on a general perspective. Furthermore, the survey research covers answers and opinions from participants located world-wide with a good diversification in age group, educational level, and fields of industry. However, based on the scope of study the data analysis is limited to the organisational function of procurement and its future change within the area of supply chain management. Related disciplines and supply chain functions (e.g. marketing, sales, operations, etc.) are not further considered in the data evaluation. Nevertheless, within future researches the following aspects should be in focus and analysed in detail. First, the location of the survey participants based on a global research to identify similarities and differences and to analyse the issues and consequences. A research question could be if the importance and impact of digitisation is higher in highly developed and automatised countries than in labour intensive countries with low salaries. Second, the field of industry to identify the opportunities and challenges as well as the gap between the manufacturing sector and the service sector. A research question could be if the importance and impact of digitisation is higher in the manufacturing or service sector and if there are differences or similarities in the sub-fields of industry. Third, the execution of interviews with employees and managers involved in the digital transformation to transfer these practical experiences and insights and derive appropriate theories as guidance for other organisations.

5.7 Final statement

The literature review and research survey results highlight the importance for organisations to take the fourth industrial revolution and therefore the digitisation as a serious issue with a high influence factor towards the future organisational success or failure. Therefore, organisations should not consider “if” they set-up a digital strategy and get their organisation and environment ready for the digital transformation rather take the required actions as soon as possible and bring the digital transformation to life. The impact of digitisation towards procurement has a positive character and organisations should take the future role of procurement and strategic network node into account when aligning its procedures and processes towards the digital strategy. Furthermore, the procurement function should get ready to build-up the required capacities and capabilities to support the organisational vision and mission from a more strategic and innovative perspective. Finally, the discipline of supply chain management will be highly influenced by the new role of the procurement function as strategic network node within supply chain ecosystems. This requires to rethink tasks, roles, and responsibilities of all supply chain parties and set-up cross-functional interdisciplinary roles to speed-up transactions and processes to stay at the cutting edge of technologies and innovation and to drive the future organisational success in the most efficient and effective way based on sustainable and diversified long-term profitability.

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Further reading

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