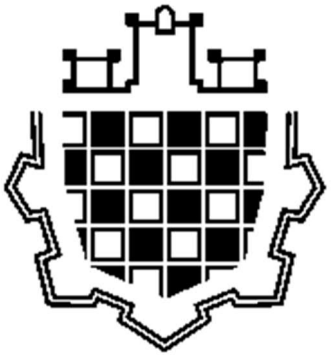

Digitalization Technologies and Business Trends in Procurement

Inauguraldissertation
zur Erlangung des akademischen Grades
eines Doktors der Wirtschaftswissenschaften
der Universität Mannheim

vorgelegt von

Jan Grünen
Heidelberg

Mannheim, September 2021

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Tag der mündlichen Prüfung: 22.10.2021

Acknowledgements

Foremost, I wish to express my sincere gratitude to my supervisor Prof. Dr. Christoph Bode, who taught me everything I needed to know about conducting research and presenting it adequately and who included me as external doctoral student into the team at the chair of the University. His continues support, guidance, and encouragement was essential for my doctoral studies and I highly appreciate the positive and goal-oriented working atmosphere as well as professionalism and enthusiasm for the combination of science and practice and I hope that our close collaboration continues beyond the dissertation. I also appreciate the effort of Prof. Dr. Hartmut Höhle for serving as secondary advisor and for his comments and suggestions especially during the early phase of the dissertation along the design science research methodology.

Second, I owe a great debt of gratitude to my family, especially my wonderful wife Kathrin, who enabled me to focus on the research work during endless hours after work and on weekends and who kept my back free of many personal obligations and in addition had excellent suggestions and feedback to my dissertation, and my children Anna and Felix, who brightened my life and respected my home-office and my research working hours whenever I needed them to do so.

Third, I would like to express my thankfulness to my employer SAP SE, which provided a framework for me to continuously exchange with colleagues and experts from the industry, who guided me along my work and who provided me with valuable thoughts to accelerate the practical relevance of my dissertation.

Table of Contents

List of Figures

List of Tables

1 Introduction and research overview

"It is not the strongest of the species that survives, nor the most intelligent that survives.

It is the one that is the most adaptable to change."

Charles Darwin | English Naturalist and Geologist (1809 – 1882)

The world is changing: Digitalization is happening everywhere, transforming the way we live and work, how business runs, how society functions - and it will continue to do this in a timeframe that is much shorter than any other major economic transition in history. Everything is becoming digitized and connected. Everything is being shared, personalized and is available at our fingertips. This trend is changing all industries and processes, placing a premium on speed, customer satisfaction, personalized products, and collaboration. These dynamics require companies to change and adopt a digitized business model that can respond immediately to dynamic changes and satisfy increasingly demanding customers. This trend does not stop at the procurement function.

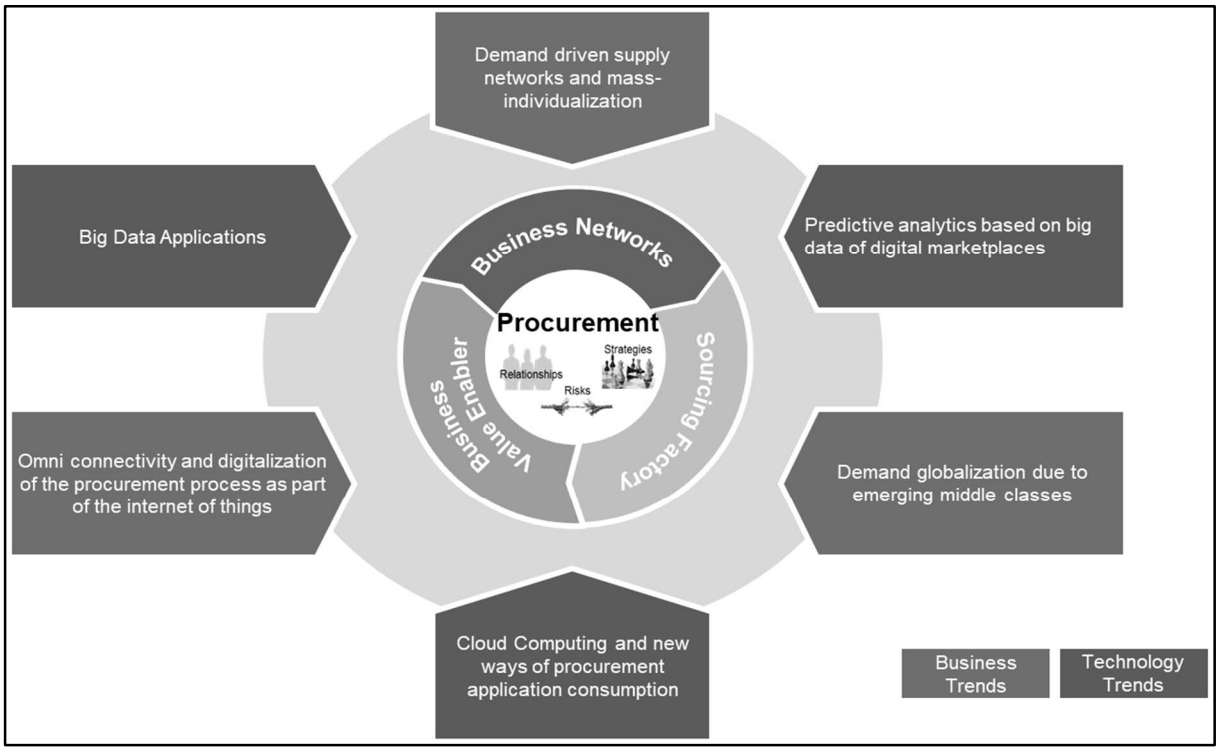
There are several business trends which support this overall transition especially in the procurement domain. Firstly, there is a globalization of demand due to the emergence of a powerful middle class. Globalization, the process of interaction and integration among people, companies, and governments of different nations across the globe, is driven by international trade and investments and is aided by information technology and digitalization. Here the factor of the emerging middle class especially in the so called BRICS countries, namely Brazil, Russia, India, China and South Africa, is resulting in a global re-balancing across geographies, not only in terms of supply, but specifically in terms of demand resulting in fast growing consumer markets in emerging markets with new market rules (Mostafa and Mahmood, 2015). In addition, new competitors such as Alibaba are entering the stage, helping to globalize

Chinese manufacturers while the Chinese market still provides huge growth potential for imports as well. Secondly, demand driven supply networks and mass-individualization enables consumers to participate in the act of customizing the product for themselves on a large scale and at low costs resulting in the fact that today's customers ask for individualized products with the millennial generation being "always on", "connected" and wanting individualized products and services on demand. For example, companies like Amazon provide new distribution strategies for consumer business, allowing them to deliver products which were ordered via their webpage within a few hours. This has major implications on the supplier network and underlying business processes. Finally, omni-connectivity and digitalization of the procurement process is becoming part of the internet of things. Industry 4.0 or "Digital Manufacturing" and the "Internet of Things", connecting everything with everything and creating a new transparency of what is where across company boundaries, has strong implications for procurement and supply networks. Leveraging these innovations for concepts such as vendor or supplier managed inventories in operational contract-based sourcing or eKanban, the electronic evolution of the traditional Kanban system, in production-oriented environments to further improve and streamline the supply chain is decreasing the risks in stock keeping such as expiration costs or out-of-stock situations. For example, the Italian pasta manufacturer Barilla is piloting new ways to produce pasta directly in selected restaurants leveraging 3D Printers to produce the required kind of pasta based on a single finished dough which will always be available at the restaurant in sufficient quantities.

These business trends are supported by evolving digitalization technologies, which further increase their impact. Big data applications allow information to be created and spread faster and less controllable as ever before: Facebook, WhatsApp, Twitter and Flickr and others are channels for employees and customers to get information and collaborate instantaneously. These applications however have unintended consequences that need to be anticipated.

Technology designed to manage big data is now capable of analyzing even bigger amounts of data quickly. What used to take weeks can now be done in seconds, thus creating the opportunity to understand the impact of incidents such as natural disasters and related delivery failures of components much quicker. Other examples show how companies in the health care sector are leveraging big data applications to fight cancer. Predictive analytics based on big data of digital marketplaces is a technique used to conduct future prognosis based on patterns in historic data as compared to traditional descriptive business analytics, which is only leveraged to visualize and package up data for consumption without the capability to provide automatic predictions. The information collected on transactions being performed on marketplaces can therefore be processed by predictive analytics to provide significant insights into general market trends. These insights can be very valuable to market participants. Kumar et al. (2006) show examples of how customer-centric predictive analytics is leveraged to predict consumer behavior. Nichols (2013) elaborates on how to craft more efficient marketing campaigns. Looking at potential business models, Google is providing internet search free of charge generating traffic but earns money with advertising and positioning of web content. Finally, cloud computing and consequently new ways of procurement application consumption provide new ways of benefiting from these technologies more quickly and efficiently. Cloud computing refers to the next architectural paradigm in IT software architectures after mainframes in the early beginnings of IT and client-server technology in the 1990s. The reduced complexity and financial risk of cloud computing requires lower IT support, resulting in a power shift from central IT departments to business departments regarding IT buying decisions in general. For example, “Software as a Service”-offerings of online marketplaces such as Amazon or Ariba now provide new ways to consume procurement applications as well in the B2B world. Figure 1 provides an overview of the outlined business and technology trends that are impacting the procurement function.

Figure 1: Overview of business and technology trends impacting procurement

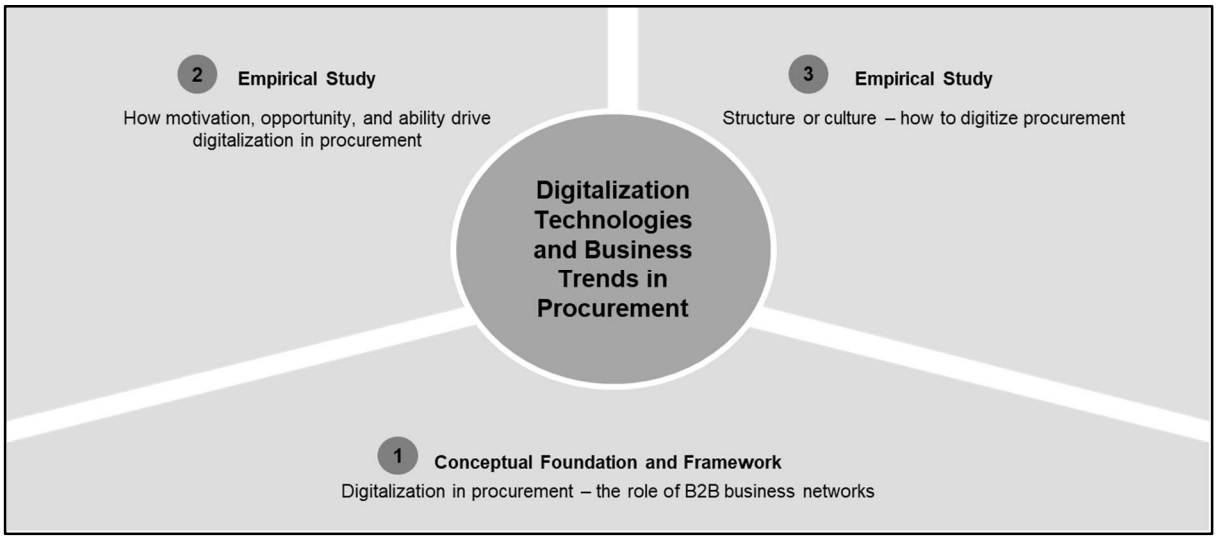


Consequently, the procurement function needs to develop concepts to respond to these digitalization trends. The strategic procurement function needs to contribute to the company challenge as “Business Value Enabler”, for example by facilitating supplier co-innovation together with the functional line of business or by provisioning of complete solutions to the problems of the line of business rather than simply acting as a fulfillment agent. Creating, contributing and leveraging business networks is another field of contribution from the procurement function. Inclusion of predictive analytics with big data analysis as competitive advantage in business forecasts as value-add services to market participants is one examples of how business networks can facilitate procurement processes. Another example showing the possible efficiency gains can be derived from integrating logistics to bundle and optimize transports and provide delivery scheduling and tracking functions. Further integration of supply plans with suppliers for securing material availability and preventing bullwhip-effects or collection and provisioning of supplier information on logistics, quality and financial aspects for supplier selection are additional capabilities of business networks that could facilitate

procurement. Further, digitalization can help to increase the operational procurement efficiency by facilitating the negotiation of contracts on a global level for local usage thus reducing direct material costs by globally consolidating purchasing volume. Finally, digitalization can help reduce inventories by providing transparency that allows to shift quantities to external distributors, reducing the days in inventories or enabling a more complete supplier view including quality and product compliance as well as import and export trade compliance and financial aspects for the supplier selection process.

This research analyzes the impact and trends resulting from digitalization in three iterative steps: First, the research starts with an overview on digitalization in procurement along a detailed analysis of B2B business networks and the direct potentials that can be derived from them. In a next step the mechanics of participating in electronic B2B business networks is further explored with regards to motivation, opportunity and ability to leverage digitalization, using the example of B2B business networks. Finally, digitalization is taken to a broader level, taking additional digitalization technologies into the picture and analyzing the digital maturity of a number of technologies and the readiness of the consuming company with the respective impact on procurement performance, drawing from the entrepreneurial orientation theory. Figure 2 provides an overview of the research approach.

Figure 2: Overview of research approach



Chapter 2 reviews fundamentals and potentials of B2B business networks considering recent developments in the domain of big data analytics that provide the basis for leveraging predictive insights, also in the procurement domain, opening the door for significant efficiency gains. After the definition of the research phenomenon the approach is to segment the different areas of the B2B business network market. This shows the heterogeneity of the market along different spend category segments and across procurement functions. It outlines relevant aspects of the existing segments and predicts future developments. Next, it is analyzed how B2B business networks facilitate the procurement activities and provide the data required to compile essential predictive insights. The focus of this study is to provide an overview of the modern concept of B2B business networks for stakeholders in the source-to-pay process, including procurement organizations, suppliers and lines of businesses. In addition, several conceptual dashboards are presented, which visualize the potentials and showcase how available data from B2B business networks could change the procurement process and how such big data intermediaries can transform industries. To illustrate the potential of predictive analytics in the procurement domain, leveraging B2B business networks, a design science approach is chosen and a number of prototypes are developed to visualize potential areas where predictive procurement insights can be injected into existing procurement processes and applications. These shall demonstrate

that B2B business networks contribute to the procurement process and provide the foundation for predictive procurement insights, leading the way for the introduction of advanced digitalization technologies in the procurement domain as soon as certain parameters are fulfilled.

In chapter 3 the question of where and how to invest in order to benefit from the digitalization trends in the procurement function is explored, taking B2B business networks into the center of analysis. Conceptually, the foundation of this study is the motivation–opportunity–ability framework, which has been applied in various management disciplines to further analyze and predict the parameters of the effectiveness of investments in digitalization. This empirical study indicates how digital realization is impacted by digital readiness, digital maturity and market pressure, structuring the phenomenon along the motivation, opportunity and ability parameters of the MOA-Framework. An online survey among procurement executives is conducted and findings on how digital readiness and maturity impact digital realization are presented, helping practitioners in the procurement domain to further understand the dynamics of the digitalization practice. This research elaborates on the question if companies in competitive environments show a higher degree of digital readiness as compared to companies in less competitive contexts, enabling them to leverage digitalization to operate efficiently and cost effectively and if companies with high processual readiness of digital processes have the ability to reach a higher state of digital realization. Additionally, it is analyzed if the perceived capability of the available technologies moderates these effects. It is found that digitalization in procurement, here with the example of B2B business networks, is happening in areas with high competition and the corresponding need for efficiencies, but only in the case that processes are already digitized. It is shown that the effect is even stronger if the perceived maturity of the technology is on a high level. The findings of this research provide guidance for executives how to tackle

the digitalization approach and provide a further example of how the motivation-opportunity-ability framework can be applied in practice.

Finally, chapter 4 extends the research area towards additional digitalization technologies and analyses the antecedents to and effects of the same. Based on the observation that organizations increasingly rely on digital innovations to improve their procurement processes and the evidence that suggests that investments in digital innovations do not necessarily guarantee enhanced organizational performance, this study draws from the entrepreneurial orientation theory, proposing that digital procurement processes serve as a catalyst in transforming digital investments into higher value for a firm. Based on data collected from surveying procurement managers in various industries, this study sheds light on these issues. The findings provide a new perspective in evaluating investments in digital innovations, especially elaborating on how cultural as well as structural aspects affect the digitalization of the procurement process. In detail, the study analyses if entrepreneurial orientation has a positive effect on the company's overall digitalization degree and if organizations with a centralized procurement function have a higher degree of digitalization, based on the fundamental assumption, that the overall digitalization degree has a positive effect on the procurement performance. It is shown that digitalization in procurement is happening more in organizations with a high entrepreneurial orientation and that this effect is supported by organizational setups where the procurement function is structured in a centralized way. From a practitioner point of view this is a strong case for centralization of procurement as well as fostering entrepreneurial orientation in the procurement domain. Conclusively, this study suggests that fostering cultural changes in terms of entrepreneurial orientation supersedes the effects towards digitalization and performance as compared to organizational centralization of the procurement function. While both approaches show a positive impact at low levels, organizational centralization proves less capable in the long run and especially at high levels of entrepreneurial orientation.

However, the data shows a disperse distribution of digitalization deployments along industry verticals with certain industries having stronger relationships towards dedicated technologies than others. In this study perspectives are given on how digitalization can create a sustained competitive advantage for a firm's procurement function. Furthermore, it gives indications which environmental attributes in terms of entrepreneurial orientation and organizational structure foster the level of digitalization. This contribution will help practitioners to provide a fertile environment for digitizing the procurement function and provides empirical evidence for researchers to build on when developing further models and hypothesis on how digitalization matters for procurement, building on the entrepreneurial orientation theory.

2 Digitalization in procurement – The role of B2B business networks

2.1 Introduction

Research on the value and concept of electronic marketplaces in general and specifically in the business-to-business (B2B) space is not new. Particularly during the 1990s and peaking around the millennium, numerous studies were conducted that revolved around these topics (e.g. Alt and Fleisch 2001; Amit and Zott 2001; Bailey and Bakos 1997; Bakos 1991; Scharl and Brandtweiner 1998; Timmers 1998). Yet, the world has significantly changed since the early 2000s. Disruptive changes in the global business environment as well as technology innovations with bilateral influences have created volatility, uncertainty and complexity in business not experienced before with the recent global covid-19 pandemic making it not easier but rather giving an extra push on digitalization. Due to evolving standards and continuously declining costs of usage, modern information and communication technologies have diffused into the business world and have facilitated new models of value creation and entirely new business processes (Zott et al. 2011). Today the business networks provider landscape consists of a heterogeneous set of operators with different operating patterns, along the maturity stages outlined by Alt and Zimmermann (2014) back from the “Proprietary era” via “Early E-Commerce” and “E-Business” through “Early digital value chains” and “Early digital ecosystems” to current “Early convergence”. These developments have spurred new trends and enabled advanced technologies such as “big data”, “internet of things”, “artificial intelligence” and “predictive analytics”, all of which highlight the importance of information goods and networks as predicted by Porter and Millar (1985) and Shapiro and Varian (2006).

In order to define the scope of research of the present study the first section provides an overview of the current market situation for stakeholders in the source-to-pay process

(including procurement organizations, suppliers, and lines of businesses), explaining the state-of-the-art concept of B2B business networks. To this end, a conceptual framework is developed informed by literature research and a thorough market analysis, which disentangles and segments the market for B2B business networks. The analysis includes a presentation of different market segments and concludes with a forecast as to which market segments and categories of B2B business networks will grow and as to whether there are certain niches that are likely to stay. To achieve this, the overall market of B2B networks is segmented with a specific focus on identifying specialist segments. The analysis includes a review of the existing marketplace categories and trading platforms, starting with an analysis of how a marketplace works in general and related to the business network setup and business model of certain segments. Ultimately, the critical question is whether generalists, operating across the segments, are likely to dominate the market as a whole in an oligopoly like in the business-to-consumer (B2C) market with players such as Amazon, eBay or Alibaba, or not. This question is important for several reasons. First, procurement organizations across all industries and geographies are continuously looking for possibilities to improve their efficiency. For all practitioners in this domain, the value proposition of online marketplaces and B2B business networks is manifold (Kauffman, Li and van Heck, 2010). Processes and tools such as smart invoicing are valuable in that they help to reduce manual efforts and prevent errors. Second, the outlook to have an electronic process, starting with a purchase order, including all related documents like order changes, order confirmations, shipping notifications, right down to the invoice is undoubtedly helpful to streamline the procurement process towards a paperless process. This again significantly increases the transparency of spend in all categories in conjunction with a reduction of process times and related efforts. From a technical perspective, B2B business networks promise seamless integration with suppliers (using a streamlined structured enablement and onboarding process for each individual supplier), so that ultimately all existing as well as potential suppliers can be linked through a single channel (Mouzakitis,

Sourouni and Askounis, 2009). This includes a value proposition for the suppliers towards online status and the progress tracking of their orders and invoices as well as other information insights (Lee, Son and Suh, 2010)

However, recent developments in the domain of big data predictive analytics have just started to influence the procurement domain. Therefore, the second section of the paper applies these new concepts known as predictive analytics to the field of procurement, leveraging B2B business networks. The B2B business network acts as a neutral and public collaboration platform, a setup in which an electronic intermediary is established as a digital trading platform facilitating the procurement process between companies (Agrawal, De Meyer and Van Wassenhove 2014; Ordanini 2005). The main value proposition of B2B business networks is to streamline business processes and foster collaboration beyond the four walls of an individual company, enabling a digital procurement function.

In contrast to existing research, this paper analyzes potential areas for B2B business networks to extend and build on their core function towards providing market information transparency as well as capabilities to predict future trends. In an environment in which digitalization and new technologies enable greater visibility, companies are forced to better understand the demand signals coming through the supply chain. The hypothesis is that B2B business networks can help market participants anticipate, understand and act on the signals in a collaborative network. Therefore, the paper describes the functions that provide predictive market insights to the participants based on the data collected in the network.

2.2 Market review and identification of clusters and categories

2.2.1 Definitions

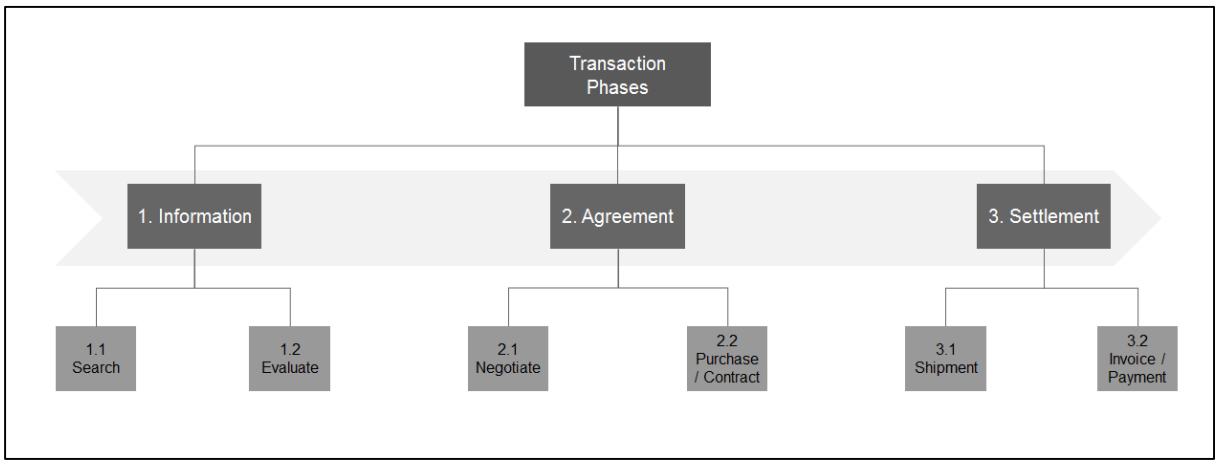
Acknowledging the fact that the e-commerce / e-business phenomenon has been researched in detail and various definitions already exist, this generic aspect is not analyzed further but it is

referred to Dai and Kauffman (2002). Instead, the focus is on the specific function in e-commerce which Alt and Fleisch (2001) describe as “electronic commerce”-type “business networking systems” (p. 11), a setup where an electronic intermediary is established to facilitate the procurement process between companies. B2B business networks are therefore defined as electronic commerce business networking systems that connect multiple corporate customers and suppliers in order to facilitate purchasing activities across various spend categories (Mahadevan 2003). Wise and Morrison (2000) analyze the B2B landscape and in addition identify buy-side as well as sell-side asset exchanges, standardizing the buyer ordering process by combining the offers on a sell-side market portal or the requests on a buy-side exchange respectively. Different concepts, including private platforms and providers of tools for such private platforms, exist in the market on both, sell-side as well as buy-side (Al-Naeem et al. 2004). Sell-side marketplaces are more comparable to electronic customer relationship management (CRM) solutions, which allow a provider, or a set of providers, to offer online e-catalogues for anonymous participants to (manually) buy from their offerings. Buy-side marketplaces are more comparable to supply chain management (SCM) supplier collaboration solutions, where an individual buyer, or a small set of buyers, provides a collaboration platform for suppliers to offer their products and services (Griffin 2005). However, to generate value for all trading partners a solution needs to exist that allows both trading parties to gain efficiencies. Therefore, those 1:1 connection hubs or 1:N collaboration portals are not considered to be B2B business networks, as they do not provide equal value to all participants. Furthermore, it is important for a B2B business network to be solution-agnostic and to provide open interfaces on both - the buy and sell side - to the respective applications leveraged (Alt und Fleisch 2001). Ideally, this integration is seamless and supports all aspects of the trading phases from information and agreement all the way to fulfilment (Chen et al. 2009). Maximum value can only be achieved from such networks if 100% of suppliers are integrated (Johnston and Mak 2000). In the cases described above either suppliers or buyers are confronted with a situation in

which they must connect their systems and adopt their processes to multiple networks, which is not ideal. Therefore, for a business network to be accepted without external pressures, it is important that multiple buyers are connected to multiple suppliers, to ensure that there are value gains for both, suppliers and buyers (Raisch 2001; Wise and Morrison 2000). A *B2B business network* shall therefore be defined as *a digital trading platform which connects multiple corporate customers and suppliers with the purpose of facilitating the purchasing activities in a dedicated spend category or across various spend categories.*

The literature on business transactions in the context of procurement is vast. For this study, the definition visualized in Figure 1 proposed by Lindemann and Schmid (1998) is followed. A B2B business network serves to better discover, connect, understand and collaborate between customers, suppliers, banks, transportation providers and other trading partners along the main three phases of a transaction: information, agreement and settlement (Cross and Gray 2013). The first phase “information”, which can also be called source and contract phase, contains the activities of the buyer who is searching for potential suppliers and evaluates individual offerings, including considerations around contracts and strategic procurement aspects. The subsequent “agreement” phase is the phase during which the actual negotiations on scope and price of the goods or services and the buying decision take place. It covers negotiation aspects as well as operational purchasing activities, such as the triggering of purchase orders and finalizing contracts. The final “settlement” phase includes the aspects of shipment and delivery, or service provisioning in case of purchase of a service, as well as the invoicing and corresponding payments. This phase closes the transaction for both parties. Turban and King (2001) suggest a similar outline of the functions of a market along matching buyers and sellers as well as facilitation of transactions, but they add institutional infrastructure as a further element.) Finally, a B2B business networks can as well be bundled with additional solutions for participating buyer and supplier organizations (Weil and Vitale 2001).

Figure 3: Simplified transaction phases in procurement process



Efficiency gains across those steps can be derived from a high level of process automation, which eliminates manual tasks along the sourcing-to-pay process. Examples of this automation are the facilitation of automatic machine-to-machine communications or structured as well as non-structured semi-manual exception-based order document processing. A high level of zero touch activities from order to payment, or ideally even starting with the request for proposal, can streamline the operational procurement process. Conceptually, those efficiency gains are based on general advantages of B2B e-commerce systems as elaborated by Laudon and Traver (2013) who identified the major benefits of those systems in the areas of lower search costs, greater market transparency for buyers, reduced inventories for suppliers and reduced transaction costs for both. Lee, Son, and Suh (2010) as well as Wielgos, Homburg and Kuehnl (2021) show additional specific benefits for sellers.

Finding 1: *Significantly evolved technology standards and declining computing and communication costs have spurred new trends and enabled advanced technologies such as "big data" and "internet of things", allowing companies to facilitate information technology to create value by connecting their digitized internal processes to their trading partners via electronic marketplaces in the B2B space.*

Research background: Transaction cost theory and network effect

Another important element of B2B business networks can be derived from the transaction cost theory which goes back to Coase (1937), who compares supplier coordination costs with the

costs of coordinating tasks inside an organizational hierarchy. Transaction costs in this context are costs incurred in making economic exchanges while information costs are costs incurred in determining the required goods' availability on the market and comparison efforts for identifying the lowest price at a given quality. Further costs include agreement costs and fulfilment costs (Coase 1937). To sum it up in simple words, these coordination costs are the main reason why companies produce components inhouse instead of purchasing them. On these fundamental considerations, Williamson (1985) develops the transaction cost theory by adding bounded rationality and opportunism. He outlines that the frequency of the transactions and specificity of the required asset for the transaction are essential. The argumentation is that for frequently traded commodities the market mechanisms are working well with lower efforts for price determination and reduced dependency on strategic partnerships (Williamson 1985). To conclude, the reduction of coordination costs will facilitate trading, while the environment of the trade is very different when dealing with frequent commodity items as compared to complex one-off deals. B2B business networks can contribute and add value with reduction of transaction costs, while the nature of the business needs to be considered (Chircu and Kauffman 2000). Another important concept for the evaluation of the business potentials of B2B business networks is the network effect, also called network externality or demand-side economies of scale. The effect is derived from the value a user can get from a good or service if other parties use the same good or service. When a network effect is present, the value of a product or service is dependent on the number of others using it. Gilder (1993) even published a way how to calculate the network effect naming it after the originator of the concept "Metcalfe's Law". The classic and intuitive example for the network effect is the telephone. The more people who own telephones, the more valuable the telephone is to each owner. This creates a positive externality because a user may purchase a telephone without intending to create value for other users but does so in any case. Online social networks work in the same way, with sites like Twitter and

Facebook becoming more attractive as more users join (Katz and Shapiro, 1985, Katz and Shapiro, 1995; Farrell and Klemperer, 2007).

This network effect is also expected to occur in B2B business networks (Kollmann, 1998; Lee and Clark, 1996), which explains why market competitors are trying to expand their footprint by covering additional segments and categories. This expansion can be achieved organically or by means of mergers and acquisitions, leading to a market consolidation with frequent takeovers as well as the formation of strategic partnerships. Based on microeconomic considerations of market equilibriums (e.g., Varian, 2014), the network effect is the main argument why the B2B business network market has a natural tendency towards a consolidation (Rochet and Tirole, 2006). Hence,

Finding 2: *The value of B2B business networks is supported by theories and academic research in the domain of transaction cost theory, confirming the business case for neutral trading platforms providing efficiency gains across the functions of the procurement process.*

2.2.2 Market categorization and structuring

Following the previous line of argumentation and building on the research of Lindemann and Schmid (1998) as well as Matook and Vessey (2008), the fundamental analysis of the market for B2B business networks is evaluated along two dimensions: traded items and industries addressed. The nature of the traded items and addressed industries help to understand the potential transaction efficiency contribution according to the transaction cost theory from Williamson (1985).

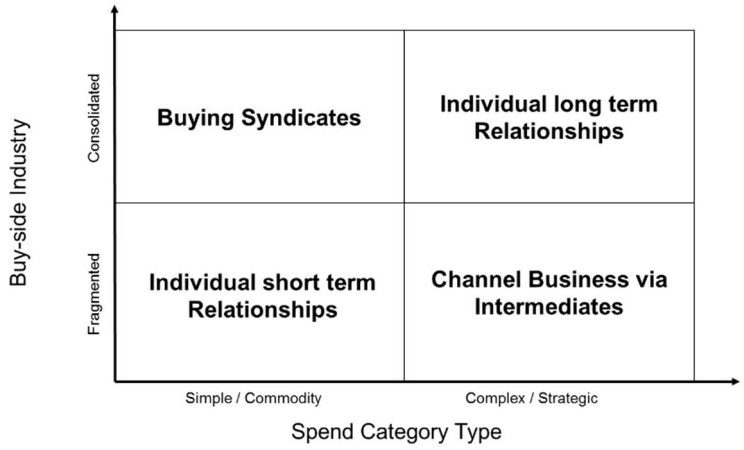
In this paper, the characteristics of the traded items to categorize the supply side of the market are leveraged. From the demand perspective, traded items can be specified as spend categories which can be broadly categorized in two types: simple, non-strategic commodity products and complex strategic items, with indirect materials such as paper and office materials or travel

services considered commodities and direct production materials or specialized services as examples of strategic complex spend categories. Spend category types are used to understand and differentiate the complexity of the business covered by a B2B business network. For this paper, the categorization of what firms buy from Kaplan and Sawhney (2000) towards operating inputs (products or services not parts of finished products) and manufacturing inputs (raw materials and components that go directly into a product or a process) is a good basis to further build on. Looking at today's B2B business network market there are B2B business network specialists for contingent labour and specialized services, travel and expense services, indirect materials, Maintenance Repair Overhaul (MRO) and other plant and production oriented requisitions, and direct products including supply chain services. This specialization on a dedicated spend category helps the B2B business network operator to cater for the specific character of the traded items and increases the trust of participants to the capabilities of the network as such. A specialized operator can gain experience along the experience curve and achieve economies of scale when integrating participants into the network (Koo, Koh and Nam, 2004). This capability to grow fast is crucial because of the network effect and the dependence of the number of participants. Generalists who try to cover all the domains are rare in today's competitive landscape, but there is certainly the trend among the competitors to horizontally extend their footprint into neighboring segments, if not organically from within the firm, then by partnering and network cooperation or by acquisitions.

The industry dimension helps to categorize the buy-side of the market. Simple categorization is done by separating mature consolidated industries with few known players from fragmented industries with many small specialized players. Especially in the domain of direct materials or MRO a strong industry focus is present in todays' markets with solutions dedicated for special industries or industry clusters such as Trading Industries, Financial Services, Discrete and Process Manufacturing, Public Services, Service Industries and Consumer Industries. The

reasons for this specialization are the specific requirements certain industries have with regards to their purchase process. The focus on a certain industry again allows the B2B business network operators to specialize and focus on the specific industry requirements, helping to understand the market conditions and to create a clear value proposition. In cases of consolidated industries with few known players, the industry players sometimes join their efforts and set up a consortium which facilitates the business of these players towards their suppliers. This bundles the power of the buying community and is a clear win on their end, however suppliers to those industries possibly supply to other industries as well and the existence of such specialized buying platforms doesn't help to reduce the efforts on their end, which is suboptimal from a global economic perspective. Figure 4 illustrates the buyer and seller dimension of B2B Networks.

Figure 4: Buyer and seller matrix along industries and spend categories



Note. Figure is loosely based on Kaplan and Sawhney (2000) and Porter (2001).

In fragmented and heterogeneous industries with many competitors two cases can be defined: for simple commodity products with low strategic importance the strategy of spot buying and short-term relationships is dominant. The main procurement aspect is the price of the good at a given quality, agreed for example on spot markets or through individual relationships with suppliers. This quadrant represents an ideal area of business for B2B business networks, given

the need for transparency and efficiency of the transactions in this domain. In case of more complex, strategic products or services the role of intermediaries is important. These agents help to connect suppliers and buyers and create transparency. The price is still important but not the main determinant, since a long-term relationship of trust is equally important. Especially in the commodity space, the role of a business network is to help gain efficiencies and streamline the transactional costs, due to the high importance of the price. In case of more complex products and services business networks can be leveraged primarily for the information phase. (Subramaniam and Shaw, 2002)

In consolidated and more homogeneous mature industries with few competitors, the situation is a little different. In case of simple commodity type products or services, the price is still the main determinant of the purchasing decision. However, in this case of non-strategic trading items and a limited number of competitors, the strategy to combine the purchasing power in buying syndicates is possible. This is different when looking at more complex and strategic goods and services. Due to the importance of the supply to the buyer, the latter is usually interested in a long-term relationship and has more decision parameters than price only. This creates another good space for business for B2B business networks, given the neutrality of the power between the parties. However, for trading partners in that domain higher expectation exist in terms of scope and features required of the facilitating B2B business network.

For a detailed understanding of the market, it is essential to analyze some additional, rather technical parameters of B2B business networks. As Alt und Fleisch (2001) elaborate, it is important for a B2B business network to be solution agnostic and to provide open interfaces on both ends – towards suppliers as well as buyers – to the respective applications leveraged. Ideally, this integration is seamless and supports all aspects of the trading phases from information to agreement and fulfilment (Chen, Daugherty and Roath, 2009). This integration ideally supports fully automatic no-touch transactions as well as manual and semi-manual

integration possibilities, which need to exist for various functions and roles. Different concepts, including private platforms and providers of tools for such private platforms, exist in the market on both ends – sell-side as well as buy-side (Al-Naeem, Rabhi, Benatallah, Ray, 2004). Sell-side marketplaces are more comparable to electronic Customer Relationship Management (CRM) solutions, which allow a provider, or a set of providers, to offer online e-catalogues for anonymous participants to (manually) buy from their offerings. Buy-side marketplaces are more comparable to Supply Chain Management (SCM) supplier collaboration solutions, where an individual buyer, or a small set of buyers, provides a collaboration platform for suppliers to provide their products and services (Griffin, Keskinocak and Savasaneril, 2005). However, in order to generate value for all trading partners a solution needs to exist which allows both trading parties to gain efficiencies. Johnston and Mak (2000) add that maximum value can be achieved from such networks if 100% of suppliers are integrated. In the described cases above either suppliers or buyers are confronted with a situation where they have to connect their systems and processes to multiple networks, a situation which is not ideal. Wise and Morrison (2000) explain that for a business network to be accepted without external pressures it is important that multiple buyers are connected to multiple suppliers, and there are value gains for both, suppliers and buyers. (Alt and Fleisch, 2001; Raisch, 2001; Wise and Morrison, 2000)

In order to gain the described network effect and sufficient traffic in terms of transactions, a valid approach for the business network operator is to partner up with other providers and provide dedicated solution islands for specific areas such as travel and expense services or contingent labor processing. Essential for such partner concepts to survive on the long run, is that the platform is able to accommodate these specific functions on a single platform with a single unique user management and a clear differentiation of the services and categories offered per network without overlapping competencies.

Another mean to grow the network is to globalize the business addressed. There are already today B2B business networks offering their goods to the global market and all regions of the world, but not all networks can address all regions in a similar way and some B2B business networks focus predominantly on one specific region only, which is then rather homogenous with regards to the participants' requirements. Only few competitors are able to cover supply needs and connect significant number of suppliers in all regions of the world. Yet, the aspect of global presence needs to be treated carefully: On the one hand, the possibility to leverage experience and technology of a trading platform on a global level allows for leveraging economies of scale. This grants the possibility to leverage degression of fixed costs from research and development as well as process innovations and provide these at lower costs to a wider audience. On the other hand, however, there is a high level of localization efforts required in order to operate on a local market with a global platform. The aspect of sufficient suppliers connected in a specific market is only one aspect here. In addition, there are requirements in terms of language requirements as well as local regulatory aspects which local operators need to adhere to. Consequently, as well a global business network operator needs to invest significantly for each local market presence. (Usunier, Roulin and Ivens, 2009) Concluding, firms operating on a global scale have an advantage due relative lower required contribution margin per each transaction facilitated, but the local requirements coverage need to be analyzed in-depth when deciding to go with such an operator.

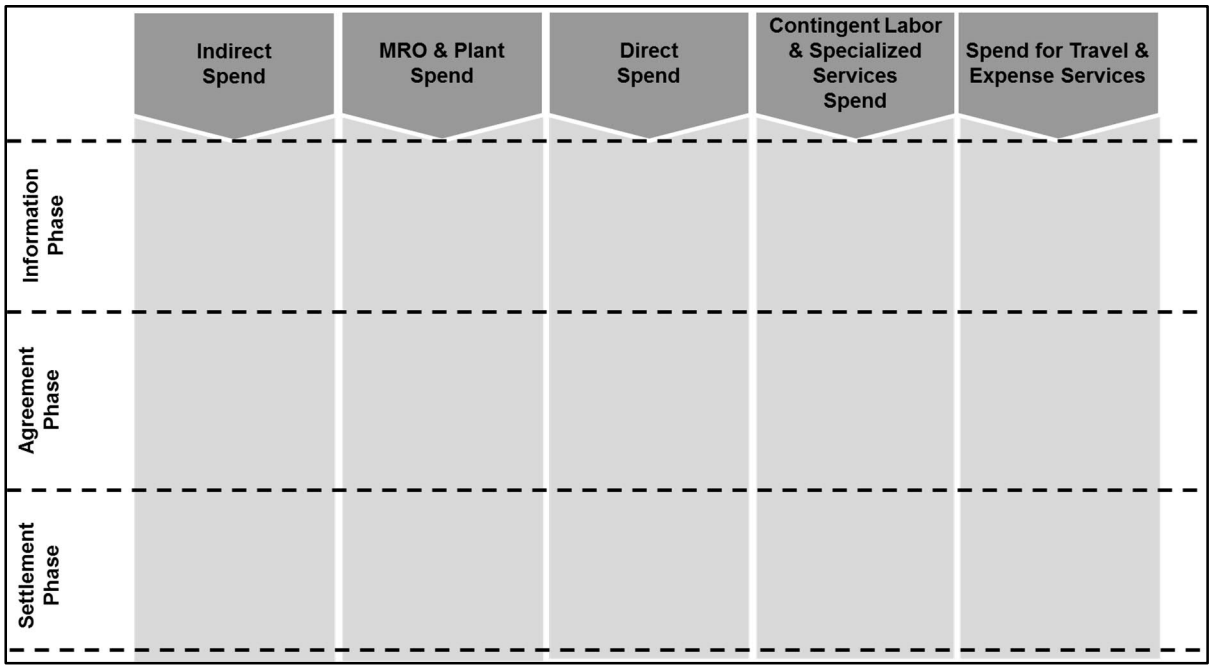
Finally, a sustainable business model is important for a business network operator to be successful (Anderson and Anderson, 2002; Turban and King, 2011). Some operators use the network as a vehicle to sell own applications or integration and other consulting services to their participants (Ellison, 2005). This should not be the main origin of cash inflow for the business network, but it needs to provide sufficient value to all participants, buyers as well as suppliers, allowing the operator to gain a margin from that value for the network as such. This

margin is best raised on a transactional basis and not as a fixed participation fee, since it makes the entrance for participants easier (Edelman, 2015). However, such a transaction-based pricing creates other challenges in the domains of transaction monitoring. The operator has to prevent misuse of the platform from free riders, which might abuse the platform for marketing or information purposes only and avoid fulfilment aspects because of associated transaction costs on the platform (Rochet and Tirole, 2006). In this model, it is critical for the B2B business network provider to provide valuable transaction automation services in the agreement and fulfilment phase. If this value is not existent or misuse cannot be prevented the entry fee model might be an alternative. Some players pursue a freemium strategy with basic usage of the network for free and value adding services for either buyers or suppliers or both on top in order to get sufficient volume onto their networks at the first place and to avoid efforts preventing fare evasion (Ellison, 2005). However, in the long run free offers are likely to disappear when the network is big enough. Thus, important for a successful network is the creation of a win-win-win situation for all, buyers, suppliers as well as network operator, with the later providing increased efficiencies along aggregation of demand or supply, creating trust, facilitating the transaction and matching buyers and sellers (Bailey and Bakos, 1997; Bakos, 1991; Rochet and Tirole, 2003). For readers interested specifically in this subject Zott, Amit and Massa (2011) provide a sophisticated research review around business models including developments in value creation in networked markets.

Figure 5a outlines segments of the market along the two dimensions introduced in the present section. The spend category dimension clusters the seller side of the market along various trade products and services. The process phases on the other dimension help to differentiate the completeness or focus of the offering of the competitors in the market. The result is a comprehensive picture of the B2B business network market that allows an analysis of the

various segments. A selection of researched and analyzed market providers can be found in the appendix.

Figure 5a: Market segmentation along spend category and procurement phase



2.2.2.1 Structuring along procurement phases

2.2.2.1.1 Information phase

The information phase mainly consists of searching and evaluating suppliers for the specified product or service. That includes functions allowing effective searching for potential suppliers and evaluating the individual offerings predominately in terms of price and quality, and regarding terms of service and other qualitative aspects. A valuable B2B business network operator in this domain provides a wide range of suppliers as well as transparency of the quality of the good or service and the corresponding prices of each offering. The network needs to facilitate supplier directories and corresponding e-catalogue access for the buyers including possibilities to share requests for proposals or purchase order initiation services. On the supplier side, the capabilities should include e-catalogue provisioning services in order to facilitate a smooth supplier onboarding process. A B2B business network can specifically focus on

providing value in this segment only, targeting the strategic procurement business function at the procurement side and the sales agent on the seller side.

2.2.2.1.2 Agreement phase

The agreement phase deals with the actual negotiations regarding scope and price of the good or service if required, and the corresponding buying decision. The required functions are negotiation mechanisms as well as operational purchasing tasks such as creation of a purchase order. A network in that domain should facilitate negotiation and auctioning platforms, purchase order integration to the buyers' operational systems and sales order integration to sellers' systems. Contract management is another important area in this domain. Again B2B business networks can focus their efforts on activities in this space only, however it is usually an extension of the functions from the information phase, but depending on the buyers industry or spend category it may be that the focus of the procurement process is more on the agreement phase and information requirements are less important.

2.2.2.1.3 Settlement phase

The settlement phase contains shipment and delivery as well as invoicing and corresponding payment of the good or service. Functions to be facilitated by a B2B business network provider are: purchase order tracking, shipping notifications, e-invoicing, quality inspections, e-payments and supplier performance management applications especially for participating buyer organizations. For suppliers features around e-invoice collections are valuable. The final settlement phase is quite a complex process. Ultimately, not only straightforward procurement processes need to be supported but also all sorts of exceptions need to be dealt with in order to close the transactions. A B2B business network in this domain needs to address various functions at buyer and seller side, including the operational procurement department, the purchasing business unit, the account payable finance unit and potentially third-party services in the space of logistics. On the seller side, a hand over from sales to operations is normally

conducted at this stage, which the B2B business network needs to cater for. These handovers involve the creation of additional collaborative documents, which need to be referenced to the original initiating documents. Some B2B business networks focus on this segment, facilitating the process called e-invoicing in order to digitize the procure to pay process, with the invoice inheriting attributes from the purchase order and delivery documents, ideally in a zero-touch paperless fashion.

2.2.2.2 Structuring along spend categories

2.2.2.2.1 Indirect spend category

The indirect spend category is probably the most mature segment in the B2B business network market. It is characterized by generic cross-industry requirements and operators in that segment do not have to distinguish too much by the industry of the buying organization. The nature of those commodity products, such as office supplies including workforce high tech equipment including mobile phones and tablet PCs, is very similar across industries and required by literally all firms of all sizes for their administrative departments and sales force.

2.2.2.2.2 MRO and plant spend category

This segment addresses industry sectors which have a significant installation and operations of machines that are required for producing their products or services. These industries include process manufacturing industries such as chemicals or oil and gas industry sectors and discrete manufacturing industries such as automotive, aerospace, industrial machinery or utilities and telecom network operators. The procurement relationships in these segments are rather long term and contracts usually contain maintenance terms and conditions. In addition to the collaboration aspects of the indirect segment, usually the procurement refers to specific part numbers and models which are usually not easily substitutable. In terms of delivery timing, there are requirements towards maintenance in small time windows, in order to minimize downtimes. With that functions around information and agreement in this space are less

important and B2B business networks in this segment focus on the settlement aspects of contract fulfilment.

2.2.2.2.3 Direct spend category

The segment of direct spend for raw materials and components that go directly into a product or a process is quite complex and differs significantly from the other segments. In addition, only manufacturing industries are interested in this spend category, especially consumer products, life sciences, automotive, industrial machinery, chemicals, aerospace and defense industry sectors. In this context purchasing volumes and transaction frequencies are significantly higher compared to the other segments. That means that the procurement costs per unit, including transactional costs of procurement, directly influence the margin of the product sold and therefore the earnings of the firm. The quality of the purchased goods might in addition directly affect the end-product, creating tracking requirements for serialized items. The nature of delivery schedules from within an agreed framework contract and small delivery time windows directly to the production line increases the need for micro-tracking of the purchase order positions and scheduling lines. In order to enable suppliers to adhere to the requirements of the customer, usually the buyer shares a mid-term forecast with the supplier, which is then confirmed by the individual supplier. These aspects create higher efforts for the line of production as compared to the billing and invoicing process in the other spend segments and therefore need to be addressed by the B2B business network operator in this segment specifically.

2.2.2.2.4 Contingent labor and specialized services spend category

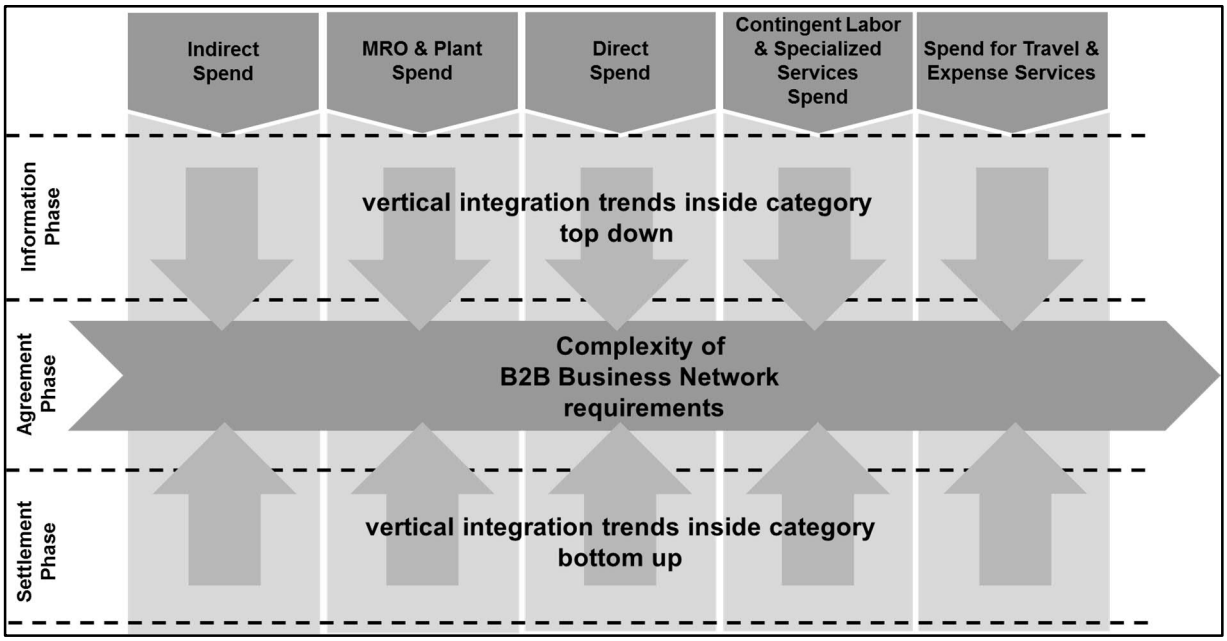
The segment dealing with contract labor is of increasing significance since outsourcing becomes more popular every year. This segment can be split in two sub-segments: low value continuous labor and specialized temporary high skilled work, both outsourced to supplying firms. The tasks included in this segment reach from simple cleaning and facility management

or security services to highly specialized IT project work or other high qualified design or marketing related activities. A common denominator of such tasks is that a contract is concluded, accompanied by documents such as a “Statement of Work”, which include milestones and daily or hourly rates of the work requested. This is then worked against by the contractor with time sheets and corresponding approvals by the customer. These activities are quite generic yet very different to the nature of the procurement in the other sectors and therefore require specific functions provided by the B2B business network operator in this segment. This is the reason why several dedicated B2B business network providers exist in this segment specifically.

2.2.2.2.5 Travel and expense spend category

Travel spend is another significant spend category for firms. A number of global travel agencies or travel brokers are taking care for the demands of corporate business travel, connecting the individual travelers to the network of hotels and airlines. However, this only covers the information segment and to some extent the agreement phase, but still many bookings are just forwarded, and the traveler ultimately holds a contract with the individual hotel or airline. Moreover, this does not even include the aspect of expense reports which handle the actual settlement of the employees’ expenses onto the firm’s accounts payables. Requirements for mobility and usage of mobile devices as well as requirements of travel service selection based on travel reviews are as well important for a B2B business network provider to facilitate when operating in this domain. This includes upcoming new trends from the sharing economy such as “Uber” or “Airbnb” (Parker et al., 2016).

Figure 5b: B2B business network market trends based on market segmentation



In sum, the analysis suggests that the complexity of the procurement process is increasing from left to right in the matrix outlined in Figure 5a where the number of documents to be shared and the intensity of collaboration across the involved parties is increasing from indirect procurement to travel spending, while all segments have their specialties. Traditionally, B2B business networks were focusing on one spend category only, but there is a trend to horizontally integrate other functions across additional spend categories present in the market, with a tendency that functions more to the right are more difficult to be addressed by operators located towards the left side outlined in Figure 5b. These insights can be summarized as follows:

Finding 3: *The market of B2B business networks is heterogeneous along multiple dimensions, with B2B business network operators providing solutions for dedicated industries and geographies as well as functions specific to certain procurement process phases or spend categories.*

2.2.3 Compendium

When looking at the categorizations and structuring possibilities discussed above, it is apparent that the market for B2B business networks is segmented and heterogeneous. Some sub-domains

of the market already exist for many years and are mature already. For example, travel service space, where global distribution systems (GDS) are operating in a traditional travel agent business in a marketplace fashion, bringing together individual travel service providers and customers, since decades. (Fodor and Werthner, 2004) The same phenomena can be seen in the domain of services, where managed service providers already offer marketplaces for individuals to offer their work to business clients. For this reason and because of the complex structure it is very difficult to count the number of competitors in the B2B business network space. However, there is a trend visible towards consolidation with frequent announcements of partnering initiatives and mergers and acquisitions between competitors inside and outside of the space. In addition, the technology environment is changing quickly, with customers now turning their attention to leveraging inter-organizational efficiencies, since intra- organizational optimization potentials have been maxed out in the past. Macro business trends circulating under the labels “digitalization” and “internet of things” or “omni-connectivity” are supported by the emergence of new IT paradigms such as “cloud computing” and “in-memory databases” creating “big data“ (OECD, 2015). These trends jointly reanimate the e-commerce domain and bring it on top of the agenda for many business deciders for upcoming investment decisions. The business value of B2B business networks as defined in this research is not disputed any longer; the main challenge in this significantly growing market space is yet the heterogeneous and fragmented process and competitor landscape.

Today, there are several domain experts existing in each spend category and process phase sector of the market. These players managed to get ahead of the competition for that special segment and they are now trying to grow their business by expanding the scope of their offering. B2B business network operators focused on the information domain providing services around supplier search and evaluation processes are targeting to add services in the settlement phase, including invoicing and payment aspects of the procurement and vice versa. This is done by

adding additional functions and features to their network offering to capture the entire end-to-end source-to-pay process of their specific domain. This will lead to increased competition inside each spend category domain and create a higher value for the participants in the networks, since they can then benefit from a comprehensive spend solution bringing together strategic procurement aspects such as supplier selection and operational procurement efficiency gains from paperless and high ratio of automatic e-invoice postings.

On the other dimension, competitors are trying to extend their services horizontally across multiple spend categories, expanding their service offering from indirect and MRO type of procurement areas towards direct and supply chain related or service-related functions, or vice versa. Again, these movements of the competitors are increasing the competition and create even more value for the network participants, since they can then benefit from connecting to a single B2B business network addressing multiple spend categories. However, the integration of additional spend categories is not simple as outlined above and it remains a challenge for the competitors to actually enable a single platform to cover multiple spend categories in a meaningful and usable way. With each category integrated there are additional functional roles addressed inside an individual corporate participant and the procurement process is different inside the different spend categories with different documents exchanged and different partnerships underneath the procurement process.

Industry segments and geographies addressed are dimensions discussed in the previous sections which are subject for consolidation approaches as well. Successful B2B business networks for specific industry sectors are looking for ways to extend their services to neighboring industries. This is clearly a disadvantage for consortiums representing buying syndicates since it destroys their superior business model in the certain segment. However, it is yet to be proven that procurement functions specific to certain industries can be covered by more generic approaches

from other sectors. Networks in dedicated regions try to become more global to attain more business, but globalization is not an easy growth strategy either, as outlined above.

To complete the picture, there are powerful generalists entering the market from outside, bringing special capabilities either from B2C e-commerce operations already operated successfully or leveraging special unique value propositions by providing a supplier base from certain regions, such as China. Special technology capabilities and a global customer base could be a good starting point for conquering the market, especially when combined with a focused acquisition strategy. Players who combine some of the capabilities outlined here and who are already present in some domains have an advantage when the market is globalizing and harmonizing.

This trend towards a market consolidation is very natural and has numerous examples in the business history, which have gone through this same consolidation phase when markets became more mature (Deans et al., 2002). In addition, in this case the network effect is present, where the number of participants in a certain B2B business network increases the value of the entire B2B business network as such (Farrell and Klemperer, 2007). The more suppliers are connected to the network, the more competition there is and the more choice is given to the participating buyers in the network. Therefore, a market with these characteristics has a trend to consolidate and leave only few players dominating the market (Posner, 1969).

Nevertheless, there are certain niches which seem sustainable and provide the space for competitors to continuously dominate the segment. These niches can be found, for example, in special industry segments with complex procurement integration aspects between small known member communities, where the power of the buying firms is big enough to force their suppliers into a B2B business network. Public sector procurement is certainly a space where governmental compliance guidelines could provide a protected foundation for dedicated B2B business networks to remain in business long-term. As well local geographic markets with

special conditions in terms of legalization and economics as well as language and cultural aspects might be a fertile soil for B2B business networks to remain independent in the long run. Finally, B2B business networks which understand to position themselves in a dedicated domain, combining language, geography, business process as well as spend category, in a way that is significantly superior to anything a generalist or competitor from another domain could offer, have the chance to survive. Collectively, this leads to the fourth finding:

Finding 4: *The number of market participants and transactions increases the value of a B2B business network for each participant. This indicates a market consolidation as elaborated in the conceptual background regarding the network effect. This consolidation is supported by multiple external business and technology trends and amplified by the existing players in the B2B business network market by expanding their business areas in order to gain market share outside of their existing business space. These joint forces suggest a market consolidation with dominance of generalists, which are likely to gain a majority of the market share in the post-consolidation era.*

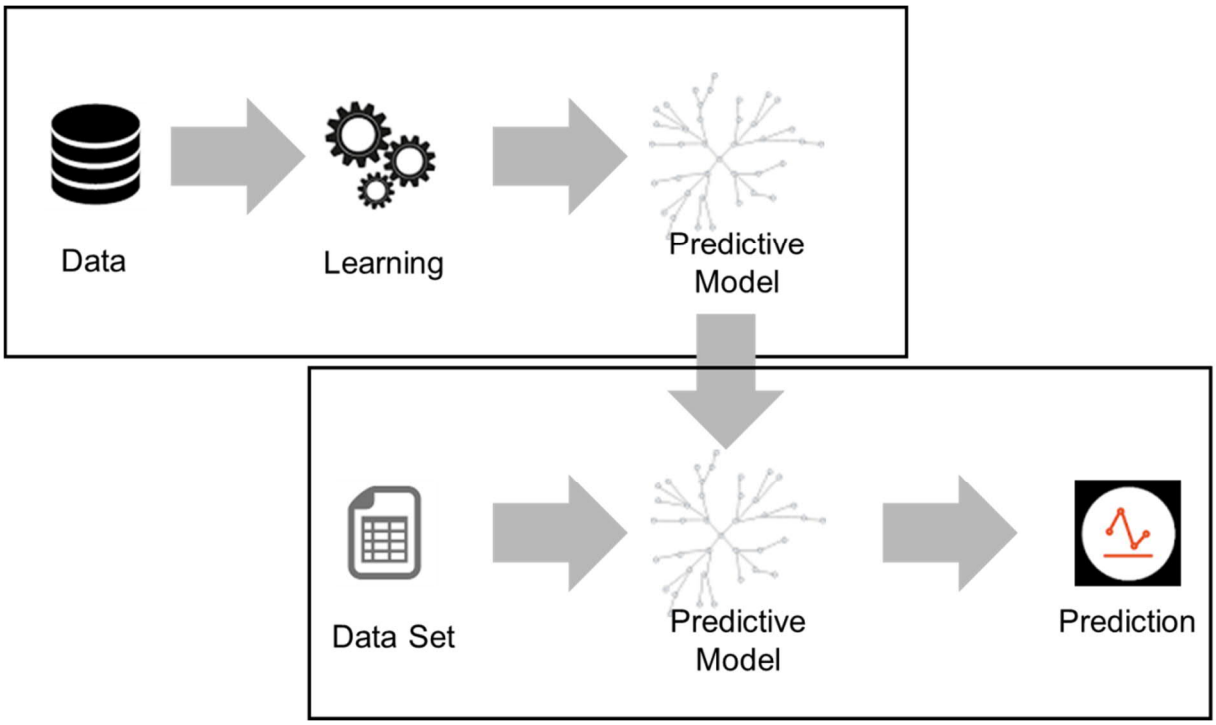
2.3 Digital application: leveraging B2B business networks for predictive procurement

2.3.1 General considerations on predictive procurement insights from B2B business networks

To attain a substantial analysis of the contribution potential of B2B business networks to the area of predictive insights, it is also important to revisit the current research in the area of predictive analytics. Predictive analytics is not a new phenomenon, especially when abstracting the concept to the question whether formal rules can be used to draw valid conclusions. Aristotle (384 - 322 B.C.) already formulated a precise set of laws governing the rational part of the mind and Thomas Hobbes (1588 - 1679) built on that paradigm by arguing that reasoning was like numerical computation (Minelli, Chambers and Dhiraj 2013). Popper (1983) concludes that the predictive character is the primary criterion for evaluating a theory and scientific progress in general. He argues that theories looking only to explain a phenomenon were weak, whereas

those that made “bold predictions” that stand the test of time despite being readily falsifiable should be taken more seriously. Applying this general hypothesis to predictive analytics, it needs to be stipulated that descriptive statistics describe what has happened in the past, while predictive analytics uses the past information to predict future outcomes with a degree of likelihood. A core requirement of data science in this context is to predict the future, not just providing capabilities to explain the past (Dhar 2013). Further drilling into the concept of predictive analytics, predictive learning, as a synonym for supervised learning, needs to be differentiated from descriptive learning, which is synonymous to unsupervised learning. In the concept of predictive learning, training data is provided to learn the mapping of inputs and outputs from one data set to create a formula that can then be applied to the entire data set to identify similar patterns. In contrast, descriptive learning is a process used to find interesting patterns in data as such, without the goal of formulating predictive statements (Murphy 2014). Predictive business analytics is a technique to conduct future prognosis, as compared to descriptive business analytics as a means to visualize and package up data for consumption (Maisel and Cokins 2014). The concept of predictive learning refers to the definition of a predictive framework in a process, in which data is analyzed for certain algorithms and patterns by using machine learning technologies to formulate predictive statements and develop predictive models. These models and statements can then be applied to a specific set of data to make predictions along the patterns seen in past data. Figure 6 outlines the general approach with regards to machine learning and predictive analytics based on Siegel (2013). It shows how predictive statements are tested on a given data set to create a predictive model, which can then be applied to individual data sets to provide a predictive score.

Figure 6: Predictive learning and application



Looking at the fundamental data used for the analysis or prediction, Dhar (2013) argues that big data promises automated actionable knowledge creation and predictive models, building the bridge between predictive analytics and big data. Big data, as defined by Sharda (2015, p. 546 ff.) is not only characterized by the volume of available data but also by the variety in terms of unstructured information and the velocity and dynamics in which the data is captured, is further changing the paradigm towards using more data to create an even better predictive model. Here predictive is considered as forward-looking analytics for specific data sets based on patterns found in historic data and construct a few potential use cases for predictive functions as part of a B2B business network. The application of predictive analytics to the field of procurement insights derived from data residing in B2B business networks will be termed *predictive procurement insights*.

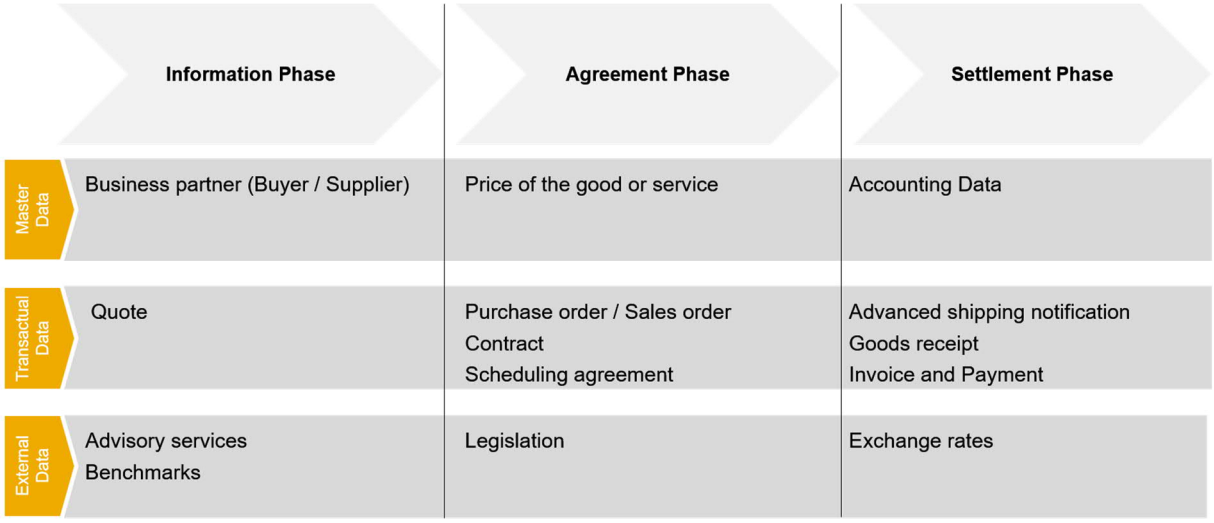
Research Background: Data structures available in B2B business networks

The application of predictive analytics to the field of procurement and B2B business networks requires a distinction of information gathered from B2B business networks from general available market research information. As outlined above, Williamson (1985) elaborates in the transaction cost theory that a reduction in transaction costs will facilitate trading and create an economic benefit. With regards to the analytical capabilities, in contrast to aggregated time bucket analysis, B2B business networks allow for real-time dynamic data analytics directly from the network, providing real-time insights into actual commerce activities. To improve data integration of the data elements from the various B2B business networks into the transactional client systems, standards are emerging (Folmer et al. 2011). A B2B business network receives a significant amount of data during the procurement process from the information, agreement and settlement phases, including master data, transactional data as well as external data (Lindemann and Schmid 1998).

The information phase, as outlined above, mainly deals with searching and evaluating suppliers for a specified product or service. A valuable B2B business network operator in this space therefore needs to determine a wide range of suppliers, ensuring transparency of the quality of the good or service and the corresponding prices of each offering. From a data perspective in this phase, the network needs to facilitate supplier directories and provide corresponding e-catalogue access for the buyers including possibilities to share requests for proposals or purchase order initiation services. On the supplier side, the capabilities could include e-catalogue provisioning services to facilitate a smooth supplier onboarding process. In the agreement phase, that deals predominately with the actual negotiations regarding scope and price of the good or service and concludes with the corresponding buying decision, the required functions are negotiation mechanisms as well as operational purchasing tasks such as creation of a purchase order. A network in that domain should provide negotiation and auctioning

functions and ensure purchase order integration to the buyers' operational systems and sales order integration to sellers' systems. Contract management is another important function in this area. In the settlement phase, containing shipment and delivery as well as invoicing and payment, data occurring in a B2B business network are derived from: purchase order tracking, shipping notifications, e-invoicing, quality inspections, e-payments and supplier performance management applications especially for participating buyer organizations. For suppliers, data supporting e-invoice collections are valuable. The final settlement phase is quite a complex process, since not only straightforward procurement processes need to be supported but also numerous exceptions need to be dealt with in order to close the transactions. A B2B business network needs to support various functions on the buyer and seller side, including the operational procurement department, the purchasing business unit, the accounts payable finance unit and potentially third-party services in the logistics space. On the seller side, a handover from sales to operations is normally conducted at this stage, which the B2B business network needs to cater for. These handovers involve the creation of additional collaborative documents, which need to be referenced to the original documents. Some B2B business networks focus on this segment, facilitating the process called e-invoicing to digitize the procure to pay process, with the invoice inheriting attributes from the purchase order and delivery documents, ideally in a zero-touch paperless fashion. Figure 7 illustrates the main elements along these phases of the procurement process.

Figure 7: Available data in B2B business networks



Master data captured in a B2B business network covers the following aspects: Business partner master data of buyers and suppliers along with the necessary details for completing the transactions such as name of business partner, address and bank account. The price of the good or service can be given or a result of an agreement and then be part of the order or contract. Accounting data includes company codes and account categories in the general ledger, such as projects or assets. The master data of the business partners allows analysis of the company size, industry and geography, of which elements such as financial health, payment information and other compliance aspects could be derived by passing risk parameters down from region and industry. Data privacy compliance as per Ohm (2014) requires that all participants agree to share their master data with the participants of the network for the dedicated usage, including predictive procurement insights. Bell (2015, p. 25 ff.) furthermore highlights that customers always must have a clear opt-in into the usage of their data, a requirement just recently put into legislation by the European Union as well. Table 1 shows the main documents and their attributes part of the procurement process.

Table 1: Transactional data documents and attributes

Document	Description
Quote	document describing the requested product/material or service from vendor and buyer side in conjunction with a request for price proposals
Sales order	offer by a supplier to the customer to deliver a quantity of materials or perform a specified service within a specified time
Purchase order (including PO change revisions)	request from a buyer to an external supplier to deliver a quantity of materials or perform a specified service within a specified time
Contract	document outlining the scope of the traded object as well as the terms of usage
Scheduling agreement	document informing the vendor which quantities of a product are to be delivered on which date/time
Advanced shipping notification	document containing all data necessary for triggering and monitoring the delivery process
Goods receipts	statement of physical acceptance of goods or materials into stock at customer side
Invoice	document that states the invoice recipient's obligations to the company that sold the products
Payment (including payment proposals, payment schedules, remittance advice, etc.)	notification that a payment is triggered in the payment run at client side

Transactional data could be cleansed to ensure the anonymity of participants and then aggregated to provide insights into macro-level information on commercial activities in industries, geographies, and markets. The dynamic predictive models could then be applied to the dedicated information derived from the individual participant to calculate predictions, following the predictive modeling approach from supervised learning. The further usage of the general transactional data, including prices, volumes and timing of purchase units is strictly limited and subject to aggregation and anonymization, since it is not owned by the B2B business network itself but belongs to the participants. Spiekermann et al. (2015) as well as Galanxh and Nah (2006) elaborate on this crucial area of data privacy and commercial usage outlining the problems of privacy issues with a focus on private persons, which can possibly be applied to B2B environments all the same. In conclusion, the assumption here is that transactional data could anonymously be derived from the underlying transactions and has the following main attributes: buyer, vendor, item, price, volume, and time stamp. This information could be leveraged to dynamically build predictive models, which could then be applied on demand by the client to their individual data sets as part of the prediction process as outlined in the conceptual background section.

Finally, external data is captured during the procurement process and covers the following aspects: market studies and other advisory services including benchmarks and legislative advisories as well as exchange rates derived from external sources for international payments. From a technical integration perspective Folmer, Oude and van Hillegersberg (2011) analyze and evaluate 34 semantic standards to evaluate their ability to improve interoperability in various industry sectors. This is a rather technical yet crucial point concerning the system interoperability required for B2B business networks. To ensure an efficient data integration of the described data elements from a B2B business network into the transactional client systems from both ends – buyer as well as supplier – a XML schema called cXML exists (cXML 2015).

2.3.2 Application of predictive procurement insights in B2B business networks

As outlined in the previous section, predictive analytics in sales and marketing is a well-researched domain. Despite sellers and buyers play an equally important role in B2B business networks (Eisenmann et al. 2006), the domain of predictive analytics in procurement is an area which has been covered less comprehensively in research up to now. Therefore, the further analysis of the potentials of predictive procurement insights is focused on the buyer and procurement perspective and this section elaborates on specific examples of how predictive procurement insights could be operationalized.

2.3.2.1 Method

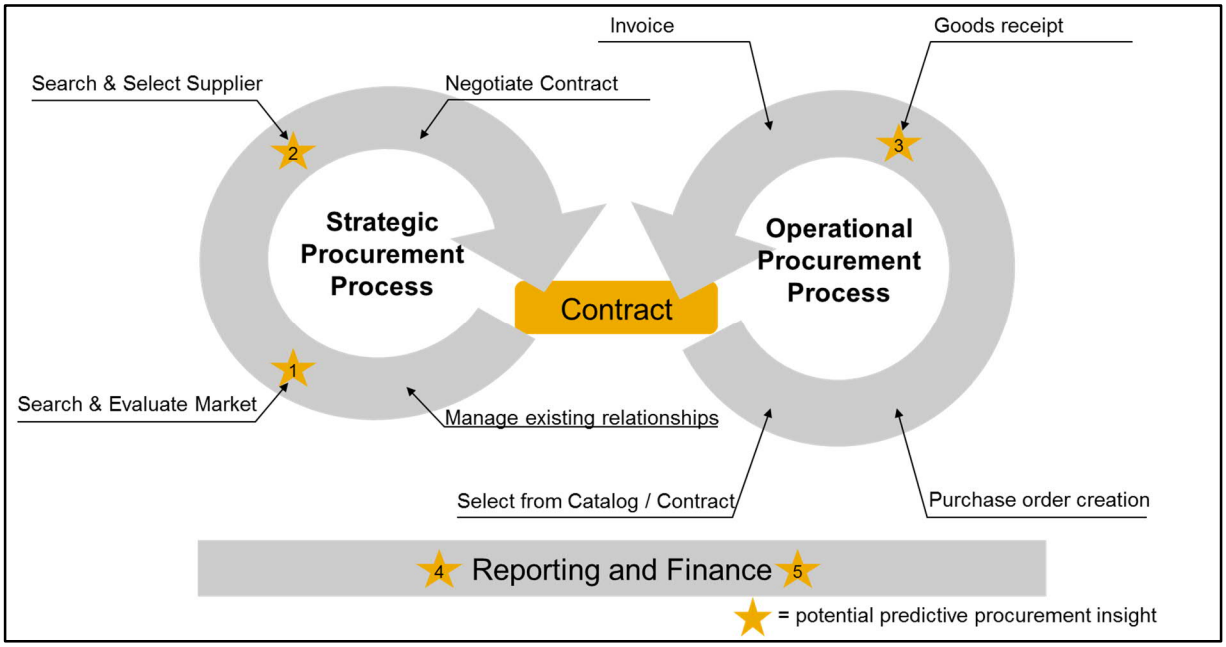
To illustrate the potentials of predictive analytics in the procurement domain, a design science approach is followed. This approach is ideal for the research objective since according to Hevner, March, Park and Ram (2004) the design-science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts. In addition, according to March and Storey (2008), the problem-focused design science

approach to bridge the gap between research and practitioners perfectly describes the desired organizational information processing capabilities and their relationship with present and desired organizational situations. It serves to develop actions that enable the implementation of information processing capabilities that move the organization toward desired situations. Gregor and Hevner (2013) further elaborate that this design science methodology is well suited to outline and design process elements as conducted below. Each prototype comprises of a design visualized in prototypes of schematic management dashboards, which consume the predictive procurement insights from a user perspective. The business motivation of each prototype is discussed before the actual artefact and evaluation metrics are given after each dashboard with the goal of "observing and measuring how well the artefact supports a solution to the problem." (Peffers et al. 2007, p. 56). This analysis is done in line with the argumentation from Vaishnavi and Keuchler (2007), who point out that the design and evaluation of an artefact typically require different skills and are therefore often conducted separately. They elaborate that although the initial presentation of a research model provides some evaluation of the artefacts, the primary evaluation is usually completed as other researchers analyze the artefacts and put them into different contexts. Thus, a complete design and evaluation is rarely completed in a single study (Vaishnavi and Keuchler 2007). Therefore, the business value segment discusses potential benefits arising from the processes outlined, each highlighting a few economic means to measure the benefits. This approach applies what Hevner et al. (2004) refer to as the "informed argument" method. That is, these metrics provide a measurement framework for further research evaluating the assumptions in real world scenarios or in lab environments, a future research topic on the researchers' agenda.

2.3.2.2 Problem identification and objectives

To identify specific applications on how predictive procurement insights can be provided based on the information available on B2B business networks, a simplified view of the procurement process is required. Figure 8 outlines strategic as well as operational procurement activities and supporting overarching functions from finance and reporting. Areas where predictive procurement insights could be leveraged are highlighted (Johnson and Flynn 2015, p. 8 ff.).

Figure 8: Simplified view on procurement processes highlighting potential predictive procurement insight areas



In the strategic procurement process the areas of “market research and evaluation” and “supplier search and selection” are selected for prototyping predictive procurement insights. Predictive procurement insight 1 is in the information phase of the procurement process whereas predictive procurement insight 2 is embedded in the supplier selection process part of the agreement phase. In the context of operational procurement, the focus is on the procurement execution inside framework contracts and selective spot-buy activities of non-catalogue items. Predictive

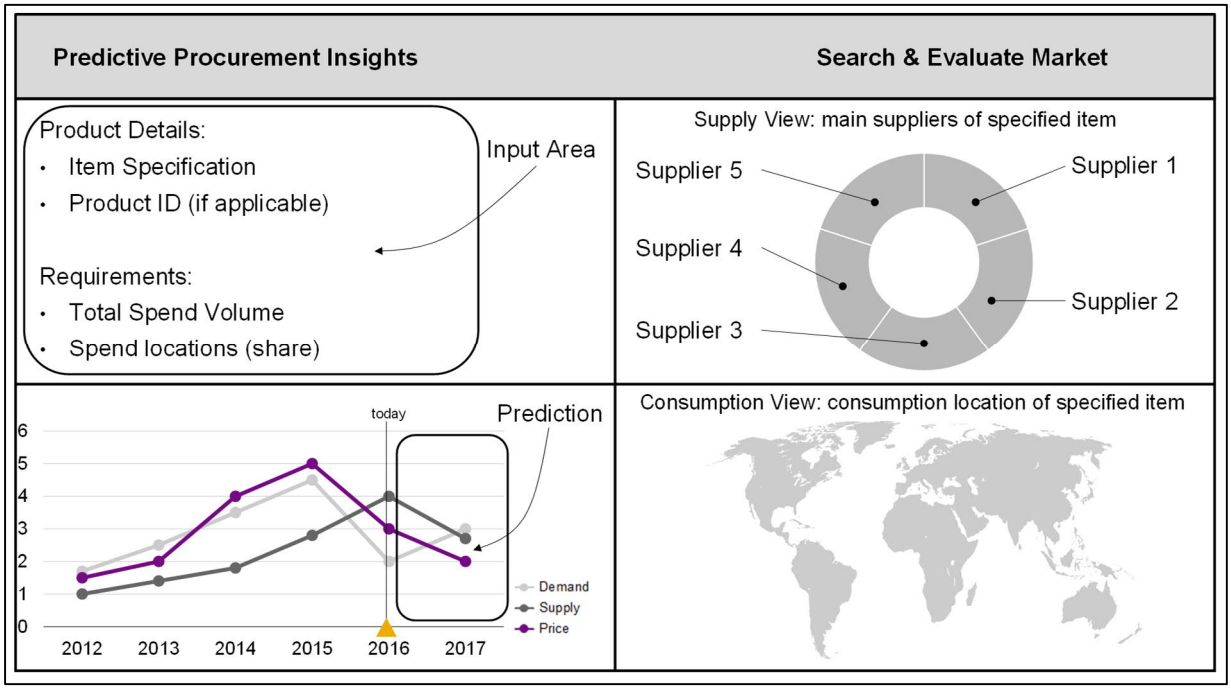
procurement insight 3 is integrated in the activity of purchasing and goods receipt as part of the settlement phase. Finally, the supporting functions finance and reporting provide a good opportunity for predictive procurement insights 4 and 5 along the end-to-end procurement process. All predictive insights as described here represent an early warning system, helping the various procurement functions to control the risks of their tasks and to enable them to act based on the best available real-time knowledge (Lindemann and Schmid 1998).

2.3.2.3 Prototypes

The following prototypes outline potential areas where predictive procurement insights can be injected into existing processes and applications. The scenarios are simplified for visualizing the potential applications and benefits for the different stages in the procurement process. They are not meant as a specification of how a solution could look like. The ultimate design depends on how these functions are realized in the individual existing procurement solution.

Predictive Procurement Prototype 1: Uncertainty and missing transparency on price trends, globally, regionally, or category related, is one of the main challenges in procurement. An ideal solution includes simulation capabilities for quantities and timelines. Furthermore, the application needs to provide real-time results to reflect short term incidents such as risks in supply of a certain trade object category that change the price prediction of a product. In addition, general economic indicators such as growth or slowdown of the global or regional economy, including certain publicly available metrics on interest rates, unemployment figures, and data from related and divergent markets need to be considered for the price prediction. Finally, insights on how competitors and other buyers are expected to behave influence the calculated market price forecast of the tradable object.

Figure 9: Predictive procurement insight 1 - price prediction in search and evaluate market phase



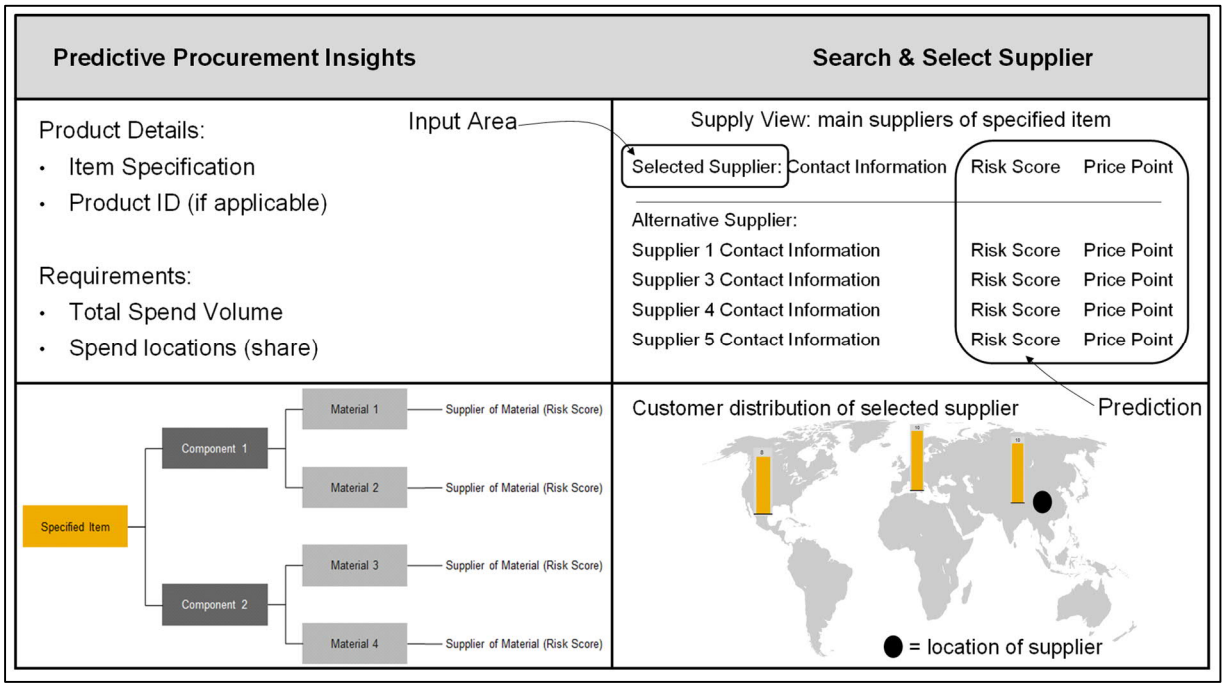
In this scenario, the strategic procurement user can analyze the market situation of the specified product in the upper right corner (market as input area) of Figure 9. Parameters include specifications of the product as well as the expected spend volumes and locations. Based on this information, vendors of the required product and corresponding supply and demand is identified. The market price prediction is provided as an extrapolation of the historic demand and supply patterns in the bottom left (marked as prediction area).

Valid predictions of future prices are undoubtedly very beneficial for procurement functions. Simulation capabilities based on existing inventories and future requirements can provide guidance on the ideal time to buy. This information is especially relevant in volatile markets with strong price fluctuations. There is a huge potential to now derive a feasible strategy, which leverages predictive insights to determine when to buy a certain product, compared with a periodic or purely demand driven procurement plan, which benchmarks own purchase conditions against general trends and enables the procurement function to leverage price

predictions to trigger procurement at times of relatively low prices. Sellers on the network that offer more attractive prices and conditions are made transparent. The impact on the price of a certain trading object from global or regional trends as well as from related and divergent markets will be of particular interest to participants. As a side note, sellers will benefit from analyzing the industry usage patterns of their trading objects and identify changing trends of usage of their products to allow them to identify new markets, as outlined by Kim and Mauborgne (2007). Additional analytical insights into their respective customer bases can be used by sellers to further improve performance, as elaborated by Lee et al. (2010).

Predictive Procurement Prototype 2: Transparency of risk patterns of the trading partners are essential for procurement and most beneficial if these are not only based on historic figures but also include a risk prediction component. Parameters defining the risk score are inventory and production locations of the supplier compared with the location in which the specified item is required. The risk score is then a result of the existing network of vendor relationships of the selected supplier and a combination of the risk of the suppliers of the supplier. The actual risk patterns are derived from historic figures from the individual suppliers based on delivery accuracy, product quality and inventories as well as transportation distances and times and financial data from the supplier. These insights are most valuable if they include regulatory and market risks of the trading partner due to the specific political, economic or geographical market environment. Finally, sustainability and environmental aspects can be included in the risk patterns, helping purchasing organizations to understand the sustainability aspects of their suppliers and leverage these in the supplier selection phase.

Figure 10: Predictive procurement insight 2 - risk prediction in supplier search and select phase



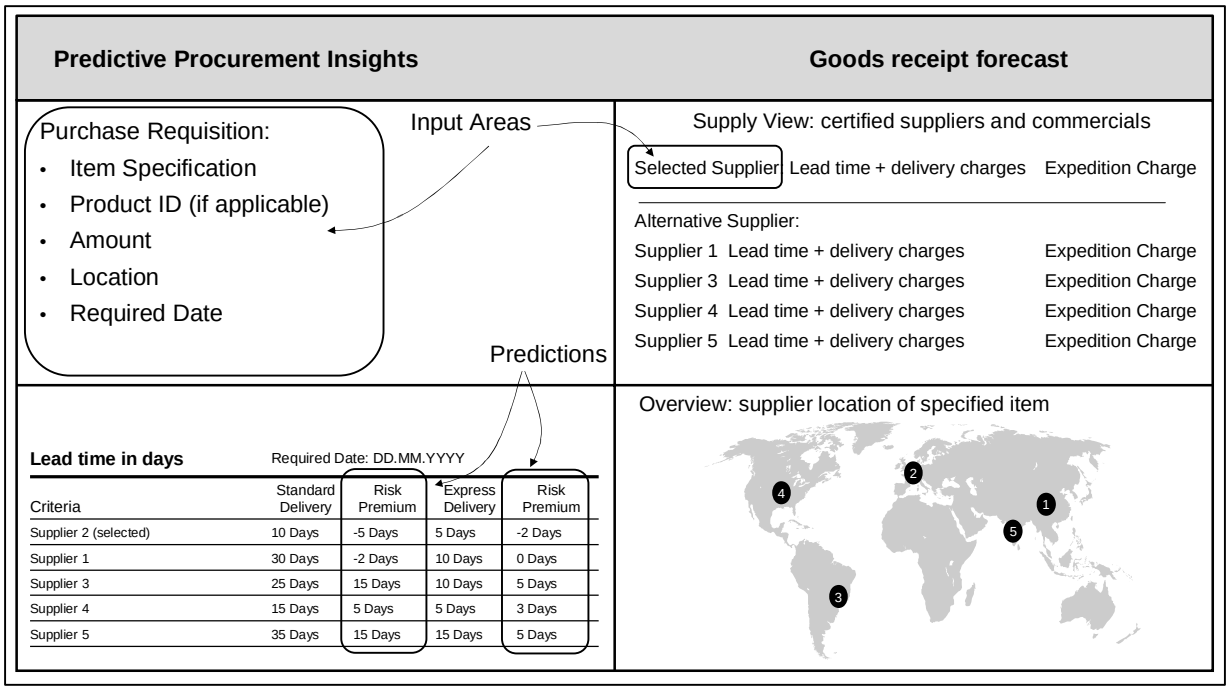
In this scenario outlined in Figure 10, the user in strategic procurement can drill down into a specific supplier from the list (marked as input area) to learn more on the environment of the vendor, resulting in the predicted risk patterns (as shown in the prediction area).

Based on this, predictive information suppliers are evaluated by risk price ratio. More comprehensive scenarios could even allow for drill down into 2nd and 3rd tier suppliers of the supplier based on the product bill of material and produce a combined risk score including these elements. This enables the procurement organization to evaluate suppliers of the required item from a risk perspective and ultimately identify the supplier offering at the best price with the lowest possible risk. Chiu et al. (2011) show how such functionality could be leveraged to automatically and systematically detect fraud in ecommerce. It must however be acknowledged that the focus on private individuals as market participants only permits a partial application to B2B environments. Finally, predictive procurement insights that allow drill-downs into components and ingredients across product pedigrees and bill of materials create additional

value along quicker and more sophisticated product compliance and risks analysis, proactively as well as exception based.

Predictive Procurement Prototype 3: Operational procurement functions lack predictive procurement insights in lead times and expected arrival dates outside of the agreed terms and conditions with the supplier. The risk predictions can be enriched with historical lead times from own purchase orders as well as delivery performance information from other deliveries from the same supplier, as available on the network (Rabinovich and Knemeyer 2006). This predictive information can further be enriched with information from weather forecasts or bottlenecks for example resulting from natural disasters, which could impact the delivery performance of suppliers from certain geographies.

Figure 11: Predictive procurement insight 3- risk premium prediction on delivery lead times



In the scenario displayed in Figure 11, the user in operational procurement selects a specific supplier from the list of certified suppliers for a specific purchase item based on the required

delivery time and standard lead times as well as potential expedition charges (input areas). The output of agreed timelines is enhanced with predicted delivery forecasts on standard and express delivery options (prediction area).

Predictive procurement insight 3 covers a prediction of the logistics performance of the supplier, improving the on-time delivery ratios. Based on this prognosis, buyers can leverage the data for operational procurement planning and logistics activities, reducing inventory levels via reduced re-order points made possible by the insights from lead times estimations as part of the goods receipt forecast process. Ultimately this leads to reduced tied-up capital in working assets.

Predictive Procurement Prototype 4: Transparency on contract spending, including prediction and forecast, often is a challenge and requires a lot of effort, especially when looking at the predicted usage of agreed volume discounts in contracts. Based on this, it is difficult to provide guidance for operational procurement behavior. This information can be derived from multiple sources, such as forecasts on planned spending from inside the organization, as historical own spend patterns with the supplier, or as supplier spend patterns from other buyers on the network, and as general economic trends.

Figure 12: Predictive procurement insight 4 - contract spending predictions for procurement reporting

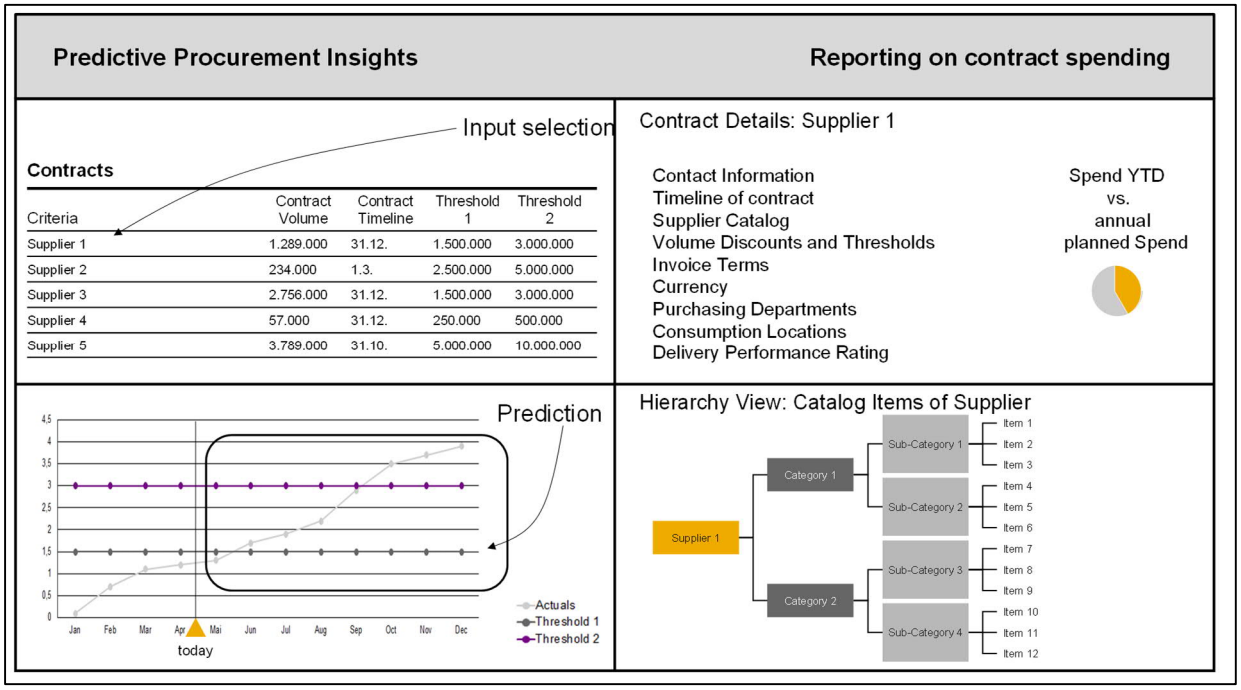


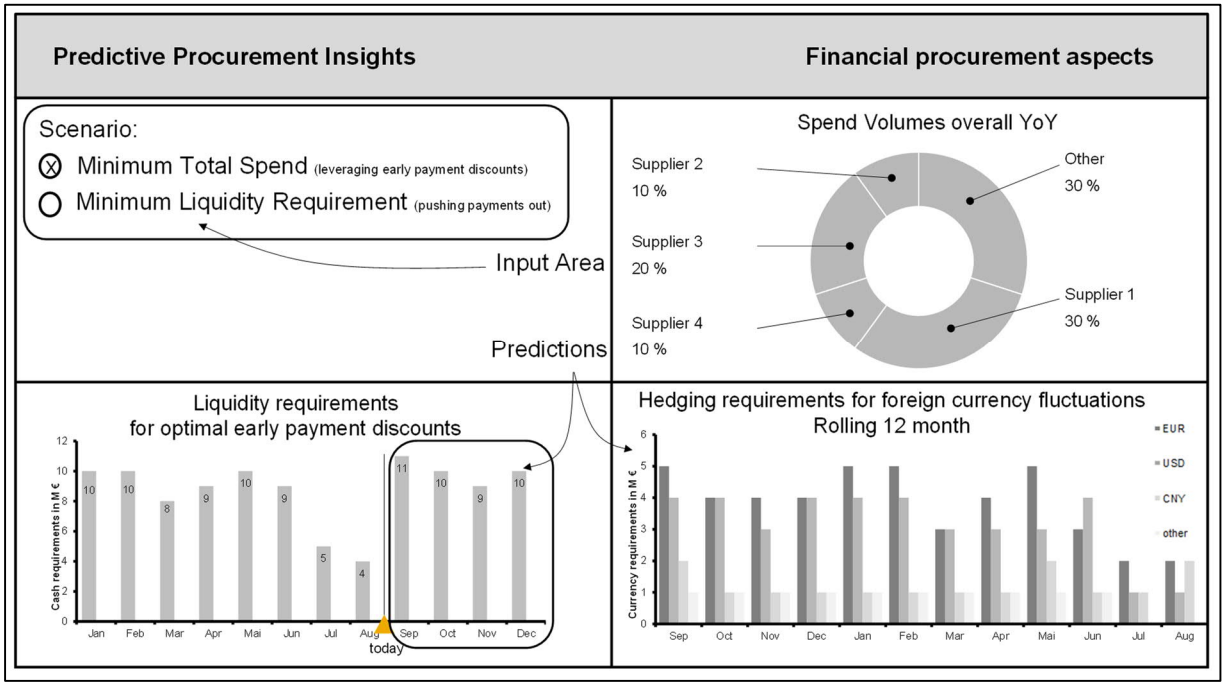
Figure 12 visualizes the reporting scenario on contract spend predictions, where the user in the procurement reporting function selects a specific contract from the list of suppliers (input area). The table shows the timelines of the contracts and the actual spend volumes year to date as well as potentially agreed thresholds for spend volumes. Using this information, the user can drill into contractual details and departments leveraging the supplier. The hierarchy view displays the products provided by the supplier. The bottom left (prediction area) shows the prediction on the annual spend.

Using this information, the procurement department can influence the procurement behavior of the organization with an enhanced operational spend guidance. The resulting improved spend volumes, as agreed with the supplier, enable volume discounts or prevent overspend outside of agreed contract volumes. The operational guidance can, for example, be executed by reducing consumption by simply removing items from the buying catalogues and steering consumption towards preferred suppliers. The latter can be achieved by promoting purchases from the

specific supplier or by disabling alternative products from the catalogues. The target here is to meet certain spend thresholds or at least enable early plan adjustments, which will then entitle the organization to agreed volume discounts or prevent costly overspend outside of agreed volumes.

Predictive Procurement Prototype 5: Finance departments benefit from predictive procurement insights derived from invoices and foreign currency payment streams in conjunction with business forecasts. This allows for insights to be gained, which can be used to plan for cash flow liquidity, in order to optimize early payment discounts and currency hedging, which prevents risks from currency fluctuations incurred by cross border multi-currency transactions.

Figure 13: Predictive procurement insight 5 - financial spend prediction on liquidity requirements



In this context, as outlined in Figure 13, the finance department has the option to choose either minimum total spend by taking advantage of early payment discounts, or minimum liquidity requirements by paying the bills as late as possible (input area). The selection depends on multiple aspects, including the liquidity situation of the company and the general interest rates

and conditions on the financial markets. The predictions on cash and foreign currency requirements can, in addition, be based on internal information on planned spending volumes from the reporting scenario before. This can be enriched with external information on general market and financial market predictions, which have the potential to strongly influence interest rates as well as foreign currency exchange rates.

From a financial aspect this predictive procurement insight enables the finance department to optimize the payment runs based on the terms of payment without incurring default charges with minimum liquidity requirements. Currency hedging requirements from cross border multi-currency transactions are another aspect that can be optimized with this function. Ultimately this enables the finance department to lower the cash liquidity reserves while optimizing the usage of liquidity to benefit from early payment discounts.

2.4 Discussion

No matter how large the value proposition of B2B business networks is, it still needs to be considered that a single procurement organization cannot participate in unlimited B2B business networks. This holds true even under the assumption that for procurement organizations only information search related efforts exist when participating in a in a purely transaction cost based B2B business network without fixed charges. Consequently, it is important for procurement organizations to understand the level market maturity and whether it makes sense to participate in a specific network. Therefore, this study analyzed the current level of maturity of the B2B network market and seeks to predict to what extent further consolidation is likely to happen, with a specific focus on the different purchasing segments. Consequently, the B2B business network market might be subject to a market consolidation. Domain specific B2B business networks have a good position for this consolidation, but the trend is multidimensional, as elaborated above. This means that it is not enough to be an expert in one domain only, since the market structure is consolidating in parallel, merging towards end-to-end process coverage and

multiple spend category coverage as well as overlaying general globalization and industry coverage trends, as elaborated above in the section on market clustering and categorization. Some niches are likely to stay, but firms who are evaluating their participation in a certain B2B business network should know that these niches usually have limitations typical for business process silos, thus they might be limited to only one spend type and or provide only limited process support across the spend process, and lastly geographical boundaries. Due to the nature of the integration and transaction costs, maximum value can be derived if spend is managed across categories. Especially due to the costs of integration, those niche players need to be analyzed carefully. As outlined in the analysis of market place types, connecting procurement systems and processes to multiple networks means increasing the costs for managing the collaboration, including analytics of spend management, while the value derivable from the participation decreases with every additional B2B business network connected. Therefore, it is not ideal to connect multiple B2B business networks, if there is no dedicated business need to do so. This business need is existent when no general B2B business network is able to cover the specifics of the industry or the region, which creates the case for niche players as elaborated in the previous section. However, buying firms still need to expect further consolidation to happen at this point, concerning niche players as well as generalist B2B business networks.

With regards to predictive procurement insights there are numerous areas where B2B business networks could potentially add significant value towards digitalizing the procurement function. However, there are prerequisites and environmental aspects to be fulfilled for those examples to become reality. For valuable and significant predictive procurement insights, the data basis of the B2B business network must be big enough to provide meaningful insights, not only on a global level but also when drilling down into certain aspects of the business into dedicated categories and geographies. Thus, the predictive procurement insights require a quite extensive usage of the trading platform for operational procurement activities, a prerequisite which most probably can only be fulfilled by a few operators in that field and only from operators covering

a broad spectrum of spend categories across a broad customer community. Furthermore, the topic of privacy is very crucial for the data provider to solve. While Solove (2006) in his taxonomy of privacy limits himself to outline possible problem areas of privacy, Ohm (2014) differentiates collection, use and disclosure of data and highlights the “Fair Information Practice Principles” (FIPPs) as well as the OECD guidelines on the protection of privacy and cross-border flows of personal data. These standards will need to be strictly obeyed by any B2B business network provider of predictive procurement insights. Additionally, these operators will need to make sure that the terms of condition are known by their customers and ensure that they are permitted to use the data within the boundaries outlined above.

2.5 Conclusion

While the fundamental procurement process doesn’t change in principle when leveraging B2B business networks there are significant value potentials when applying digitalization to the procurement process. However, this is still a evolving technology with dynamic changes and no mature market yet. Therefore, there are several topics where more research is needed in the domain of B2B business networks. First, quantification of the value of B2B business network impacts on transaction volumes and purchasing behaviors needs still to be proven. The assumption is that the business model shift of marketplaces from participation fees, historically “stall rents”, to pure transaction-based pricing, will contribute to the value of B2B business networks. This is partially because suppliers no longer need to apply fixed cost degression to the cost of sales but are competing on a purely linear cost behavior when looking at the overlay cost of sales. A further application of transaction cost theory with the assumption that transaction costs move closer to zero in an environment where B2B business networks are leveraged in an almost “perfect market” might show significant impacts on the overall transaction volumes and make-or-buy decisions of purchasing organizations. However, there might be other costs of participation when looking at the purchasing behavior of procurement

organizations, which need closer analysis. The complexity of procurement decisions across multiple lines of business and along the product lifecycle from discovery, connection, and collaboration with customers, suppliers, banks, transportation providers and other trading partners therefore needs further investigation. Another interesting research aspect is the analysis of the business models of B2B business networks, elaborating on the concept of integration of partners via a shop-in-shop concept or as network of networks, a trend to grow networks by connecting to others thus the business model of a B2B business network operating purely as a business network platform provider. This rather technology focused analysis could include the aspect how cloud computing and software as a service concepts change the cost of integration and participation in B2B business networks. Finally, a third element of further research is the question of whether there are other features or services that B2B business networks could provide to their participants. This includes aspects such as predictive analytical insights, automatic matching of buyers and sellers, suggestion or automatic combination of additional product or services, integration of smart devices as in “internet of things” facilitating automatic ordering, and facilitating fundamental shifts in the supply chains in the area of 3D printing. Guaranteeing compliance with pre-set quality and product guidelines and locally imposed legal import and export trade laws for purchases conducted via the network are other interesting areas a B2B business network could and will possibly be contributing to.

Therefore, the application use case deep dive into predictive procurement insights helps to evaluate the question if B2B business networks can contribute to the procurement process by providing predictive procurement insights. This Paper outlines that this is the case, given that certain parameters are fulfilled: Firstly, the data collected in the network must be big and rich enough to provide meaningful insights on micro-levels of the business. Secondly, the legal and moral aspects of data privacy must be fulfilled, including updated and agreed terms of usage of the network by the participants, to permit the B2B business network operator to use the data obtained in the process. These parameters are not easily fulfilled, and it might take another

couple of years of consolidation and experience in the field until this finally becomes reality. A pragmatic approach would be to leverage the data in a stepwise manner and to introduce the concept incrementally. As a first step, the data could be analyzed in internal pilots in research collaboration with companies experienced in the field of data analytics and predictions, without monetization and with a limited focus. The positive learnings gained from these pilots could then be used to highlight the benefits and be shared jointly with the updated usage term contracts, encouraging further participants to opt-in. The field of predictive analytics is broad and there is much to learn throughout the journey. Further research should therefore select a promising field of predictive procurement insights of B2B business networks and construct an example based on data available to showcase the potential in a real world or lab environment. Privacy concerns will be there along the way and it will be crucial to address them in every pilot and with every iterative approach in this domain.

This deep dive into predictive procurement insights from B2B business networks provides only one possible technology application where two evolving technologies are combined and promise great value. However, there are many more advancing technologies to build on for digitalization, providing an open space for future research.

3 How motivation, opportunity, and ability drive digitalization in procurement

3.1 Introduction

The world is changing and topics such as “Process Digitalization” and “Big Data” are on top of the mind of many executives in many domains. Due to evolving standards and continuously declining costs of usage, modern information and communication technologies have diffused into the business world and have facilitated new models of value creation and new business processes (Zott et al. 2011). This development has spurred new trends and enables advanced technologies such as “internet of things”, “artificial intelligence”, and “predictive analytics”, which highlight the importance of information goods and networks as predicted by Porter and Millar (1985) and Shapiro and Varian (2006). This digitalization promises procurement organizations across all industries and geographies to improve their efficiency (Kauffman et al. 2010). One central enabling element of digitalization in procurement are B2B business networks. In accordance with existing research B2B business networks are recognized as electronic commerce business networking systems connecting multiple corporate customers and suppliers in order to facilitate purchasing activities across various spend categories (Mahadevan 2003). Most benefits arise if the B2B business network acts as a neutral and public collaboration platform in a setup in which an electronic intermediary is established as a digital trading platform facilitating the procurement process between companies (Agrawal et al. 2014 and Ordanini 2005). The main goal of B2B business networks is digitizing business processes and fostering collaboration beyond the four walls of an individual company to better discover, connect, understand and collaborate between customers, suppliers, banks, transportation providers and other trading partners along the main three phases of a transaction: information, agreement and settlement (Cross and Gray 2013). Additional tools facilitating procurement

processes such as smart invoicing or predictive analytics can be employed on top of B2B business networks and add further value as they help to reduce manual efforts and prevent errors. Therefore, B2B business networks are considered as entry point towards digital procurement. Electronic processes that start with a purchase order, including all related documents like order changes, order confirmations, shipping notifications and invoice is significantly increasing the transparency of spend in all categories in conjunction with a reduction of process times and related efforts, especially when seamlessly integrated with all suppliers through a single channel (Mouzakitis et al. 2009). Conceptually, those efficiency gains are based on general advantages of digital processes as elaborated by Laudon and Traver (2013), who identified the major benefits of electronics procurement systems in the areas of lower search costs and greater market transparency for buyers, reduced inventories for suppliers and reduced transaction costs for both. This generates a value proposition for the suppliers towards online status and the progress tracking of their orders and invoices as well as other potentially valuable insights from the supplier as well as the buyer's perspective (Lee et al. 2010). These advancements help to increase the automatization of operative tasks and to focus on strategic aspects in procurement. Furthermore, it allows companies to efficiently facilitate modern information technology to create value by digitizing and integrating their digitized internal processes with their trading partners, creating new conditions (OECD 2015). With this value proposition B2B business networks are a natural entry point into the digitalization journey.

Thus, the elements and tools for deploying B2B business networks and corresponding digital processes are broad. Digitalization is not just deploying software for certain processes. In practice the decision where and how to embark on the digitalization journey is much more disperse and depends on several prerequisites. Despite the motivation to be part of the digitalization initiatives of the industry and the company, procurement practitioners have the

challenge to decide where to start with which initiative, including deployment of software tools. Clearly, the motivation is essential, but the success may depend as well on other aspects such as ability to leverage digitalization and the opportunity to leverage the digital tools.

This study therefore analyses these parameters of digitalization in supply chains and procurement from multiple dimensions. The main aspects analyzed in this study are the following three:

i. Why is the state of digitalization in firms' procurement functions and supply chains so heterogeneous and which factors can explain this heterogeneity?
ii. Are there interrelations that can be identified between these factors that impact the level in which digitalization technologies are deployed in supply chain and procurement?
iii. Where should executives' pay attention to accelerating the digitalization journey?

3.2 Digitalization transformation in procurement

In general, digitalization provides one of the most influential technology changes in recent years, encompassing effects on individuals, businesses, and society (Hagberg, Sundstrom, and Egels-Zandén 2016). Digitalization and investments in information technology can be linked to higher productivity and organizational transformation, leveraging general purpose applications that enable organizations in general and in specific the procurement departments to higher efficiency and effectiveness (Brynjolfsson and Hitt 2000). The wealth of recent and maturing innovations in digitalization in great. Elements fostering this digital transformation are for example internal collaboration tools, electronic applications facilitating collaboration among individuals that are engaged in a common task using electronic technologies (Kock et al. 2001) or digital applications facilitating the collaborative planning, forecasting and replenishment process with suppliers (Fliedner 2003). Cloud computing is enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (Mell and

Grace 2011). Another generic example for digitalization investments is artificial intelligence solutions, which are software applications that when deployed solve problems that would otherwise require intelligence when performed by people (Kurzweil 1990). Technologies used in decision support systems, which are solutions looking at data derived from on-line transactional systems and making them available for on-line analytical processing (Turban et al. 2014) could potentially include and leverage new paradigms, such as predictive analytics. In these concepts modelling using statistical and machine learning techniques is employed to predict future patterns based on historical data coming from own transactional systems as well as other sources which might contain huge business data that might not be structured in the same way (Waller and Fawcett 2013; Maisel and Cokins 2014). Sensor data from connected objects part of the internet of things could be leveraged to innovate new and advanced business processes (Zouganeli and Svinnset 2009) and 3D printing potentially enables small quantities of customized goods to be produced at relatively low costs with the potential to revolutionize manufacturing and to enable companies to operate with little or no unsold finished goods inventory (Berman 2012).

Attracted by the effects these digitalization innovations promise, organizations are investing into digitalization and the corresponding transformations. The research branch of Gartner analyzed that global IT spending reached $3.7 trillion and predicts an increase of global IT spending in 2018 by 6.2% (Gartner IT 2018) and the Economic World Forum in cooperation with Accenture reports corporate investments in new technologies of $1.5 trillion in 2016 with an expected annual growth rate of 13% to $2.4 trillion in 2020 (World Economic Forum 2018).

However, the question as to how to start or continue the digitalization journey and where to place investments remains still open for many practitioners, and it may not only be limited to choose the right innovation to invest in, but may be broader. As elaborated before, B2B business networks are chosen as a digital innovation to further analyze this phenomenon in this research.

In addition, the “Technology Adoption Model” gives additional research indications. As explained by Davis, Bagozzi and Warshaw (1989), the “Technology Adaption Model” outlines that ‘perceived usefulness’ and ‘perceived ease of use’ are among other variables important factors impacting the general adoption of technology solutions. Venkatesh and Bala (2008) develop the model further and identify variables including ‘subjective norms’, ‘result demonstrability’, ‘image’, ‘job relevance’, ‘output quality’ as additional influencing factors. This research further builds on this model and frames the hypothesis that the actual usage of B2B business networks depends on the perceived maturity of the solution as well as the digital readiness of the underlying procurement processes.

3.3 Conceptual Framework

Despite the continues growth of innovations in digitalization and the investments that flow into digitalization, it remains unclear in which circumstances companies invest in digitalization and where the investments are placed efficiently. Concrete digitalization implementations that result in a high state of digital realization (SoD) are only one option amongst others, such as investments in process reengineering improving the digital readiness of the underlying procurement processes or basic research on available technologies in order to increase the understanding and applicability of the technology to the business operation. Consequently, the digitalization phenomenon needs to be assessed to understand what motivates investments in digitalization and which conditions need to be met in order to have a higher degree of actual implementations of digitalization tools. The following items are identified as relevant for a further drill down to understand the realization mechanics of digitalization in procurement: *Market pressure* (MP) as indicator for the need to increase efficiencies, with the underlying assumption that companies derive their procurement strategy from the corporate strategy (Cousins, 2008). Consequently, companies in competitive environments have a stronger need to streamline procurement processes towards effectiveness and therefore have a higher stimulus

to investigate digitalization opportunities and corresponding implementations of digital tools. *Companies digital readiness* (DR) of the procurement process, measuring the processual readiness for digitalization, or in other words the extent to which procurement processes are electronically executed or paper based and consequently data transparency is existing or not. The observation is that companies with higher digital readiness have a higher realization of digital tools. *Digital maturity* (DM) as perceived maturity of the available digitalization technologies. This is the technical readiness, representing the attitude and perception of digitalization as a mean to increase the competitiveness and efficiency of the company in general. Companies that rate the maturity of digitalization tools higher have a higher degree of digitalization tools implemented.

3.3.1 Motivation–opportunity–ability (MOA) framework

In order to further drill into the identified dimensions of digitalization elements and the deployment in procurement processes the MOA framework is chosen to structure these items. The MOA framework is well established as a theoretical basis and has been successfully applied in various management disciplines over the last decades, for example to explain work performance (Boudreau et al. 2003), business decision making (Wu et al. 2004), or consumer behaviors (MacInnis et al. 1991). In general, motivation explains the willingness to act, opportunity represents environmental attributes that enable the action, and ability represents the skills or capabilities required for the action (Rothschild 1999).

The origins of the MOA framework go back to business psychologist who studied employees' ability to execute their tasks and who assumed performance as a function of training (e.g. Lawshe 1945) as well as social psychologists, who studied the impact of motivation on performance (e.g.,Wyatt 1934). Opportunity was added at a later point to explain external factors that prevent employees from good performance (e.g. Peters and O'Connor 1980), creating a discussion in literature on how to measure and model motivation (Mitchell and

Daniels 2003). Blumberg and Pringle (1982) elaborate that motivation, opportunity, and ability are related constructs (E. Siemsen et al. 2008).

Cummings and Schwab (1973, 46) elaborate that interaction has to take place between ability and motivations, explaining that “someone with no ability to complete a task cannot successfully perform no matter how highly motivated he may be to do so. Likewise, at least some modest amount of motivation is required, regardless of one’s ability to do a task, before we can expect successful performance.”

Looking at the different MOA variables, Maclnnis, Moorman, and Jaworski (1991) have presented a model of information processing of advertising in which motivation, opportunity, and ability influence consumers' level of processing and shed light on the sort of tactics that might be useful in developing an advertising campaign.

Going forward, these components are modified to have value for the management of procurement functions and identify tactics that can be developed to enhance the probability of achieving future desired levels of MOA to successfully engage in digitalization in procurement.

Motivation incorporates readiness, willingness, interest, and desire to engage in information processing (MacInnis et al. 1991). Applying this to the context of this research, motivation is defined as a companies’ desire or willingness to engage in digitalization, derived from the competitive pressure and consequent need to streamline processes towards effectiveness, earlier identified as item a). Companies with high motivation will be willing to allocate the necessary personal and financial resources to invest in digitalization.

Ability can be described as the extent to which companies have the necessary resources (e.g. knowledge, money) to make an outcome happen (Hoyer and MacInnis 1997). In this study digital readiness, which is the extent to which procurement processes are electronically

executed or paper based and consequently data transparency is existing or not - earlier identified as item b) - is identified as the ability variable of the MOA framework.

Opportunity reflects the extent to which the environment is appropriate to achieve a desired outcome. MacInnis and Jaworski (1989) outline factors such as the time available or attention paid, to enhance or impede a desired outcome. Thus, opportunity can be positively or negatively influencing the outcome (MacInnis et al. 1991). Extending the original definition to the context of digitalization in procurement, digital maturity, representing the attitude and perception of digitalization is identified as a mean to increase the competitiveness and efficiency of the company, item c) from above, as the as the opportunity variable of the MOA framework. It represents the state to which a company has the opportunity to digitize the procurement function.

Next, a model is developed to apply the MOA framework as measurement approach to the adopted MOA variables.

3.3.2 Hypothesis

As outlined above, it is assumed that the strive to outpace competition does not necessarily lead to investments in digitalization tools to raise efficiency gains, if the digital readiness of the procurement processes is not high enough. Market pressure influences the digital readiness, making this the main driver for the actual state of digital realization. To be more precise, while digital readiness is a direct function of the market pressure of the business unit, the actual state of digital realization is connected to market pressure only through the digital readiness. This means that, in order to increase the realization level of digitalization, business units must increase digital readiness.

H_{1a}: *The higher the market pressure the more the firm's digital readiness.*

H_{1b}: *The higher the digital readiness the higher is the firm's state of digital realization.*

Furthermore, it is suggested that the maturity of digitalization technologies is making these effects stronger, influencing the effects between the market pressure and the digital readiness as well as the digital readiness and the actual state of digitalization, which reflects the investments in digitalization tools.

In order to increase the digital readiness, the motivation to increase the efficiency is not enough, but the opportunity (i.e. digital maturity) has to be on a certain level as well. In other words, this hypothesis postulates that firms need to have a sufficient technological basis in terms of tools and people know how, in order to increase the digital readiness.

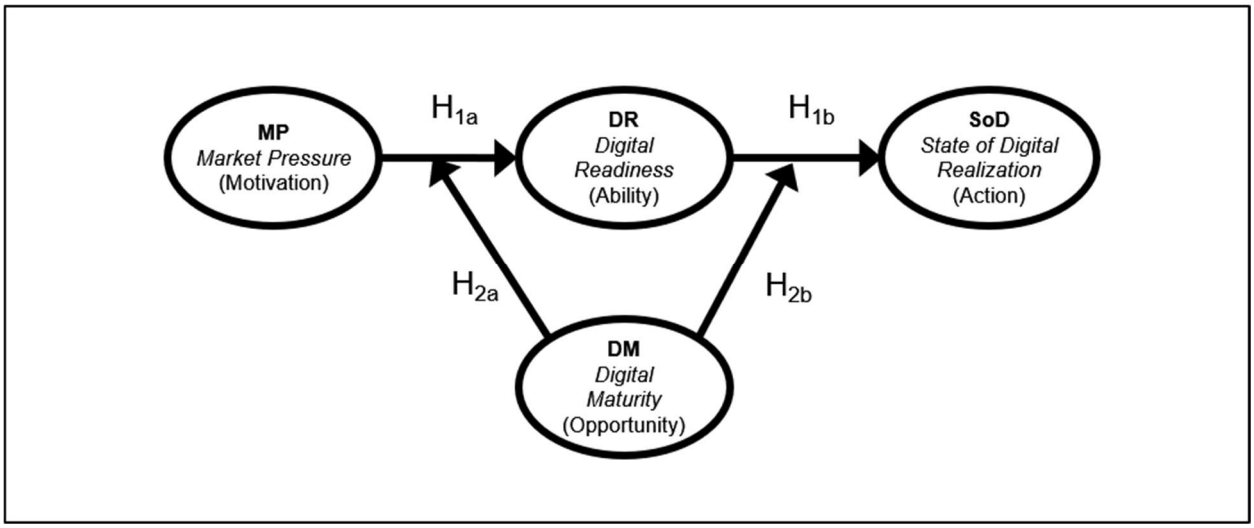
H_{2a}: *Digital maturity moderates the effect of market pressure on digital readiness.*

In addition, in order to increase the state of digitalization realization, digital readiness is not enough, but the opportunity (i.e. digital maturity) has to have a certain level as well. Companies need the right technological basis in terms of tools and people know how in order to increase the state of digital realization.

H_{2b}: *Digital maturity moderates the effect of digital readiness on the state of digitalization.*

The following figure 14 visualizes the postulated relationships.

Figure 14: Impact of market pressure, digital readiness, digital maturity on digital realization



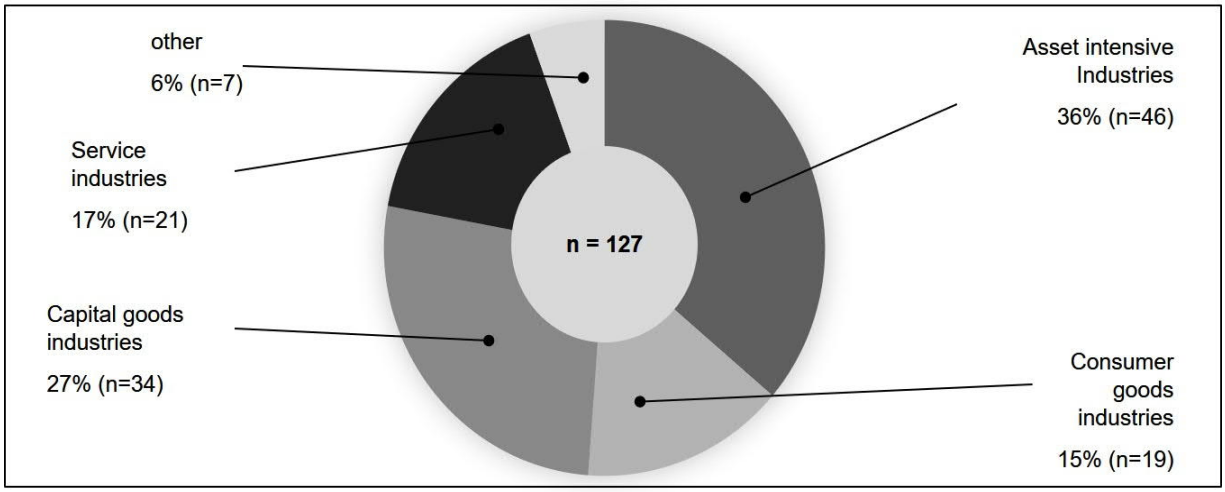
The model in figure 12 shows market pressure (MP) as independent variable with procurement digital readiness (DR) as mediator and procurement digital maturity (DM) as moderator and state of digital realization (SoD) as the dependent variable.

3.4 Research Method

3.4.1 Data

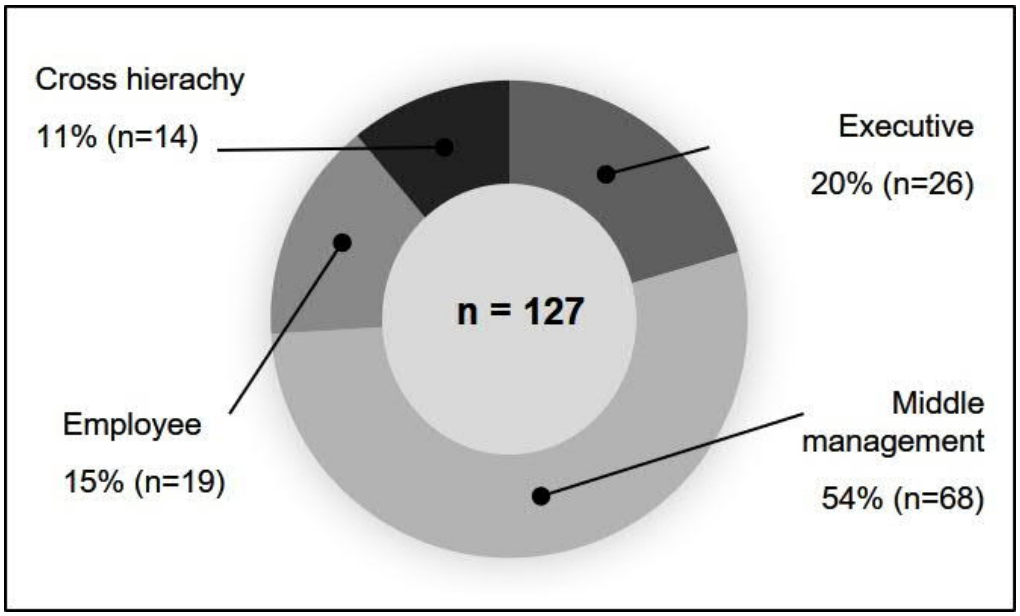
The foundation of the study is a survey that was conducted in 2017 and that was targeted at executives in procurement and supply chain management functions. A total of 650 individuals in German speaking countries were contacted, accompanied by an additional web campaign, generating another 486 impressions on the online survey form. The resulting qualified data pool consists of 127 complete data sets, roughly 9% of the total reach. To start, in the following some descriptive statistics regarding the respondents. The respondents belong to various industries, which are broken down into the following clusters, per their purchasing characteristics: First, asset intensive industries are differentiated, including construction, chemicals, oil, gas, raw materials, paper, pharma, health, and telco. These industries are characterized by high requirements towards infrastructure and machinery investments. In a second category consumer goods industries are seen, including not only consumer goods, but as well retail and textiles industries. These industries have a B2C orientation and relatively short product life cycles, thus dynamic requirements towards suppliers. The next cluster is capital goods industries, including automobile, hi-tech, fine mechanics, optics, medical technology, semiconductor, aerospace and defense and mechanical engineering. These industries are B2B orientated and have relatively long product life cycles, meaning less dynamics in terms of supplier requirements. The last cluster is service industries, that include banks and insurances as well as services in the areas of transport and IT. From a procurement perspective, these industries are characterized by predominantly indirect product requirements. The overall distribution of the respondents per industry cluster is shown in Figure 15.

Figure 15: Industry distribution



Another dimension regarding the characteristics of the respondents is their managerial level. In the survey respondents are classified regarding their managerial level: executive level, middle management, employee and cross hierarchy, meaning e.g. procurement officer, corporate strategy, project or program management or consulting. The overall distribution is shown in Figure 16.

Figure 16: Respondents management level distribution



In the questionnaire participants are asked several questions in order to understand the market pressure, as well as the digital readiness, digital maturity and actual digitalization realization

level of the respective company. For analyzing the market pressure, a previously developed and validated scale in the pertinent literature (Johnson and Sohi 2001) is leveraged. For the remaining constructs specific to digitalization, new measures for which standard scale development techniques are followed (DeVellis 2012) are developed.

3.4.2 Measures

For measuring the *market pressure* (MP) (M = 3.60, SD = 0.83, α = 0.901), reflective construct is used to derive the extent to which a firm is oriented towards achieving competitive dominance from Johnson and Sohi (2001), asking if an aggressive business strategy is pursued or if there is a strive to outpace competition. MP identifies the market pressure and motivation to increase efficiencies of the research object. High values indicate high motivation to increase efficiencies.

For capturing the *digital readiness* (DR) (M = 3,56, SD = 0.85, α = 0.854), a reflective construct was developed, asking if processes are performed purely on paper, or if process automation and digitalization are a core element of the strategy of the business unit. This construct is used to measure the digital readiness of the procurement process and therefore the ability to leverage digitalization of the research object. High values indicate a high ability to leverage digitalization.

Digital maturity (DM) (M = 3.87, SD = 0.61, α = 0.667) is measured based on a construct evaluating the questions if B2B business networks provide a very good possibility to efficiently process transactions and to include external data in the procurement decision, and conviction on benefit of digital tools for strategic procurement decisions. This construct is used to measure the digital maturity of the available technology and therefore opportunity to leverage digitalization of the research object. High values indicate high opportunity to leverage digitalization.

Finally, the actual *state of digital realization* (SoD) (M = 1.85, SD = 1.03) is measured by the perceived value and realization level of B2B business networks in the respective business unit, leveraging the question if the company evaluates the deployment of a B2B business networks. All cases where respondents answer with "Don't know" are excluded and an interval scale from one to four, with the values one for respondents who answer with "No", two for answer "Yes – mid- to long term", three for "Yes – soon" and four for "Yes, already today" is created. With this dependent variable the digital realization level of B2B business networks is measured.

Table 2: Bivariate correlations and descriptive statistics

	M	**SD**	**(1)**	**(2)**	**(3)**	**(4)**
(1) Market Pressure	3.60	0.83	0.639	*0.045*	*0.014*	*0.048*
(2) Digital Readiness	3.56	0.85	0.211*	0.614	*0.000*	*0.172*
(3) Digital Maturity	3.87	0.61	–0.117	–0.013	0.432	*0.056*
(4) State of Digital Realization	1.85	1.03	0.220*	0.415***	0.237**	–

Note. Table shows Pearson correlation coefficients below the diagonal; diagonal values represent average variances extracted (AVE) (where appropriate); squared correlations (shared variance) are shown above the diagonal in italics (n = 127).

* $p < 0.05$ (equals $|r| > 0.17$), ** $p < 0.01$ (equals $|r| > 0.23$), *** $p < 0.001$ (equals $|r| > 0.29$) (two-tailed).

Table 2 shows the correlation between the survey constructs, as well as the average variances extracted as proposed by Fornell and Larcker (1981) and the squared correlations. A simple regression analysis shows linear relations between two constructs and doesn't consider moderation effects, which in this case due to analysis of the construct DM are believed to exist: B2B business networks develop independently from the situation of a specific company. Therefore, the factor DM is modelled as moderator and not as direct influencer to SoD. The relative low correlations of DM with the other constructs, that directly influence the individual company are not in conflict with this assumption.

In a first step the properties of the four different constructs of the model (MP, DR, DM, and SoD) are assessed by means of a covariance-based confirmatory factor analysis (CFA). A maximum-likelihood estimation with robust standard errors using the MLR estimator in the statistical software package Lavaan (0.6-2) in *R* is applied (Rosseel 2012). The measurement

model reveals an acceptable fit to the data (Hair et al., 2014): CFI = 0.925, TLI = 0.908, SRMR = 0.069, and RMSEA = 0.080 (90% confidence interval = [0.058, 0.103]).[1]

Table 3: Confirmatory factor analysis of reflective constructs

Measures and associated indicators	Coefficient alpha	Composite reliability	λ	SE	*t*-value[a]	R^2
Market pressure (Motivation)	0.90	0.87				
Compared to the main competitors... (1: not at all – 5: to a very large extent)						
(1) we are pursuing a more aggressive business strategy.			0.60	–[b]	–[b]	0.36
(2) we are striving to outpace competition.			0.78	0.14	10.04	0.61
(3) we are pursuing more ambitious targets.			0.88	0.19	8.63	0.78
(4) we are working harder to achieve a competitive advantage.			0.90	0.18	8.58	0.81
(5) we strive stronger to be the market leader.			0.86	0.18	8.81	0.74
Digital readiness (Ability)	0.85	0.82				
Looking at the procurement processes of your business unit, ... (1: strongly disagree – 5: strongly agree)						
(1) no process is performed purely on paper.			0.69	–[b]	–[b]	0.48
(2) state-of-the-art IT solutions are deployed.			0.79	0.09	9.58	0.63
(3) strategic decisions in procurement are conducted based on detailed data analysis.			0.75	0.13	6.71	0.57
(4) data collected in the procurement process are stored electronically.			0.65	0.19	3.89	0.43
(5) for new sourcing decisions all data from earlier transactions and analysis is available and can be leveraged.			0.67	0.16	4.78	0.45
(6) process automation and standardization as well as digitalization are a core element of the strategy of the business unit.			0.65	0.11	7.59	0.42
Digital maturity (Opportunity)	0.67	0.79				
Looking at the maturity of modern digitalization technologies (1: strongly disagree – 5: strongly agree)						
(1) B2B business networks provide a very good possibility to efficiently process transactions.			0.54	–[b]	–[b]	0.29
(2) B2B business networks have a very good potential to include external data in the procurement decision.			0.99	0.62	2.68	0.98
(3) conviction on benefit of digital tools for strategic procurement decisions.			0.41	0.14	4.43	0.17

Note. All items were measured on 5-point rating scales (Likert-type) with higher numbers reflecting increases in the underlying constructs. λ refers to standardized factor loading and *SE* refers to standard error (asymptotically robust estimate).

[a] *t*-values are from the unstandardized solution. All factor loadings are significant at the $p < 0.001$ level (two-tailed).

[b] Factor loading was fixed at 1.0 for identification purposes.

Table 3 shows that with only one exception (DM3), each item loads on its hypothesized factor with a large loading and the overall model-fit is significant. Composite reliabilities and average variances extracted meet or exceed the common cut-off values of 0.70 and 0.50 (Hair 2014), respectively. With this analysis it can be confirmed that the latent variables are well justified.

[1] CFI refers to comparative fit index; TLI refers to Tucker-Lewis index (also non-normed fit index , NNFI); SRMR refers to standardized root mean square residual; RMSEA refers to root mean square error of approximation.

3.5 Analysis and results

Given the hypotheses, the following two equations (models) are specified and ordinary-least squares (OLS) regression is used to estimate the parameters:

(1) $DR = a_0 + a_1 MP + \underbrace{a_2 DM + a_3 MP \times DM}_{\text{[Opportunity]}} + \varepsilon_1$ [Motivation→Ability]

(2) $SoD = b_0 + b_1 DR + \underbrace{b_2 DM + b_3 DR \times DM}_{\text{[Opportunity]}} + \varepsilon_2$ [Ability→Action]

In the first equation, digital readiness (ability) is regressed against market pressure (motivation) while, in the second equation, state of digital realization (action) is regressed against digital readiness (ability). In both equations, the opportunity aspect (digital maturity) is modelled as moderating effect. For each regression model, influence diagnostics are scrutinized and it is verified that the assumptions underlying OLS estimation are met. Residuals appear to be approximately normally distributed and neither the scrutinized influence diagnostics nor the Bonferroni-adjusted outlier test raised concerns over outliers. No indications of multicollinearity are found: zero-order correlations were within normal ranges large (Table 1) and the variance inflation factors (maximum: 1.08) and the condition numbers (maximum: 1.38) are substantially below the commonly suggested thresholds for all models (Cohen et al. 2003). In summary, these analyzes do not give reason to assume that the chosen method is inappropriate. The results appear in Table 4.

Table 4: Results of regression analysis

	Digital readiness (*Motivation→Ability*)			State of digital realization (Ability→Action)		
	Est.	**SE**	**CI**	**Est.**	**SE**	**CI**
Constant	0.019	0.087	[–0.153; 0.190]	–0.002	0.077	[–0.151; 0.148]
Market Pressure [Motivation]	0.230	0.088 **	**[0.037; 0.396]**	0.189	0.080 **	**[0.010; 0.337]**
Digital Readiness [Ability]				0.380	0.079 ***	**[0.225; 0.554]**
Digital Maturity [Opportunity]	0.016	0.088	[–0.153; 0.181]	0.249	0.779 **	**[0.067; 0.419]**
Market Pressure × Digital Maturity	0.165	0.088 †	[–0.084; 0.325]			
Digital Readiness × Digital Maturity				–0.139	0.779 †	[–0.337; 0.007]
R^2	0.072			0.277		
F	3.163	*		11.690	***	

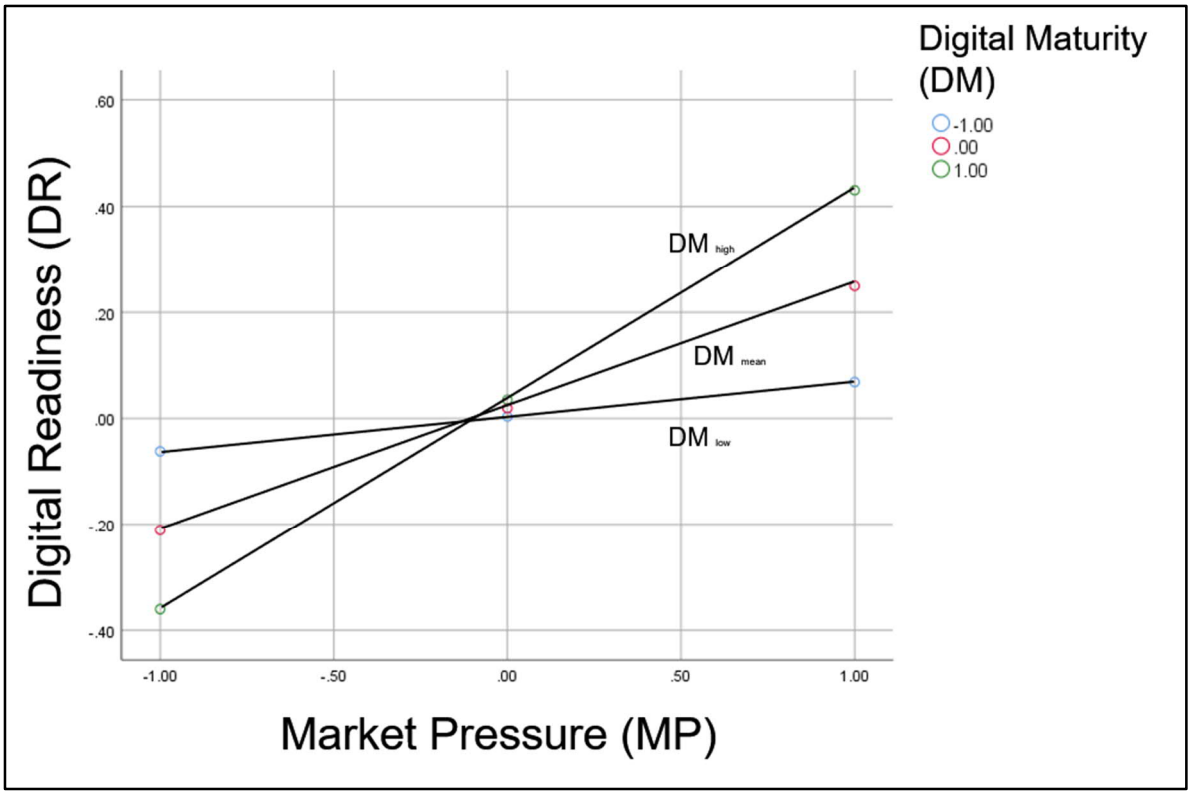
Note. Bootstrapped 95%-confidence intervals (50,000 samples, BCa) are shown in brackets. Intervals that do not contain zero are **highlighted in bold font**. (n = 127).
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed).

In the hypotheses it is asked, first, if firms with high market pressure show a high degree on digital readiness, providing them the ability to leverage digitalization to operate cost efficient (H_{1a}). The results from the analysis, as outlined in Table 3, support this hypothesis with a significant positive effect of MP on DR (standardized regression coefficient = 0.23, $p < 0.01$), as compared to the direct effect of MP on SoD (0.19, $p < 0.01$). The next question is, if firms with high level of digital readiness have the ability to action, thus high state of digital realization (H_{1b}). As well, this hypothesis is supported by the analysis with a significant strong effect of DR on SoD (0.38, $p < 0.001$). Thus, introducing DR as mediator to the model serves well to explain the variance of SoD.

Finally, a moderation parameter of DM as postulated by H_{2a} and H_{2b} is introduced. Simple slope analysis is used to explain the effects from the introduction of DM as moderator, differentiating between two effects as outlined in the corresponding hypotheses.

First, it is analyzed if digital maturity, i.e. perceived capability of the available technology, moderates the relationship of market pressure and digital readiness (H_{2a}). As compared to the effect without the moderator (0.23, $p < 0.01$), at low levels of DM there is no significant effect between MP and DR (0.07, $p > 0,05$) while at high levels of DM the effect can be clearly seen (0.4, $p < 0.01$). Figure 17 shows the plot of the moderation analysis.

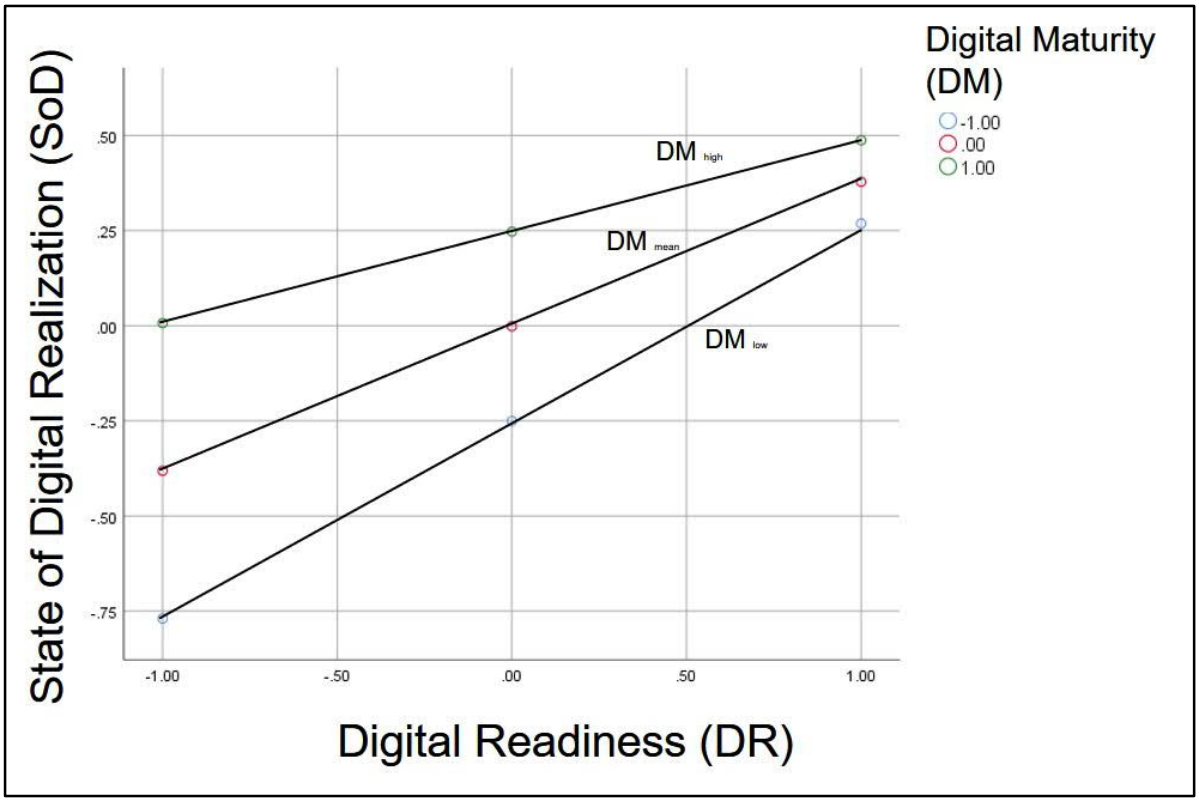
Figure 17: Simple slope analysis of moderation effect of digital maturity on market pressure and digital readiness



This means that if digital maturity has a certain level it has a positive impact on the effect of market pressure on digital readiness. In other words, if perceived capability of the available technology exists a high market pressure does lead to increased digital readiness. H_{2a} is therefore supported.

Finally, the moderation effect of DM on DR and SoD is analyzed. It is suggested that digital maturity moderates the relationship of digital readiness on the state of digitalization (H_{2b}). As compared to the effect without the moderator (0.38, $p < 0.001$), at low levels of DM there is a significant effect between DR and SoD (0.52, $p < 0.001$) while at high levels of DM the effect is still there but smaller (0.24, $p < 0.05$), supporting H_{2b}. Figure 18 shows the plot of the moderation analysis.

Figure 18: Simple slope analysis of moderation effect of digital maturity on digital readiness and state of digital realization



This means that the perceived capability of the available technology does have a strong impact on the companies' state of digital realization, especially at low levels of digital maturity.

To conclude, a high perceived digital maturity helps companies in competitive environments to develop a high digital readiness which then has a positive impact on the state of digital realization, thus the implementation of procurement processes leveraging a B2B business network.

Although not an element of the theory, the model can also be interpreted as a simple mediation model (Motivation→Ability→Action). For this reason, and to see whether the effect of digital readiness on state of digital realization could be simply explained by market pressure (i.e. no mediation), a mediation analysis using the bootstrapping procedure suggested by Preacher and

Hayes (2004) is conducted. The results (indirect effect = 0.087 with bootstrapped percentile CI = [0.013; 0.176]; direct effect *c'* = 0.015 with Normal-theory based *p* = 0.255 and bootstrapped percentile CI = [–0.009, 0.043] calculated using the MEDIATE macro by Hayes and Preacher in SPSS 26) suggest that the cooperativeness of response fully mediates the relationship between the buyer's dependence and the supplier's profitability. Hence, cooperativeness of response plays the key role in explaining how the observed suppliers recover from their financial distress.

3.6 Discussion

Digitalization in procurement, here with the example of investments in B2B business networks as facilitator of procurement processes, is happening in areas with high competition and the corresponding need for efficiencies, but only in the case that processes are already digitized, providing the ability to benefit from digitalization. The effect is even stronger if the perceived maturity of the technology available is existing.

From a managerial point of view this means, that investments in process and technical aspects to increase both, digital readiness on process level as well as digital maturity perception on technical level, are a prerequisite for digitalization. Companies need to differentiate between two fundamental aspects of their current situation with regards to procurement processes, assuming they are in a competitive environment and want to increase the level of digitalization in their processes: (1) If digital maturity is perceived low this is the focal point for the digital transformation. Companies in this situation need to invest in educating themselves by investigating tools and solutions available on the market to increase the maturity perception of digitalization tools. (2) If digital readiness is low, initiatives and investment allocations need to go into reengineering and digitizing the fundamental procurement processes, providing a better basis for more advanced capabilities in procurement processes such as leveraging B2B business networks and subsequently artificial intelligence or machine learning.

Investments in digitizing procurement processes (2) are then beneficial if digital maturity perception (1) is already high. Otherwise there is a risk of inefficient resource allocation and focus should first be put on increasing the digital maturity perception. Consequently, both elements are essential factors for the digital transformation of procurement processes towards more advanced capabilities, in this example B2B business networks.

The findings of this research have a major impact on the way executives need to tackle the digitalization approach. It means that direct investments in applications and corresponding process changes will only have a limited impact, putting digitalization investments at risk. Instead, investments should as well be directed to processual digital readiness as well as technological digital maturity, in order to increase the digital readiness and maturity levels. This will then provide the basis for sustainable investments in the digitalization applications, such as B2B business networks and other digitalization applications.

3.7 Conclusion

With this research it is shown how the MOA-Framework can be applied to complex questions in operations management functions, helping to structure the different parameters of the research challenge and show the implications of parameters towards the general research question. The mediation-moderation framework is leveraged to apply the MOA framework to this research question. This shows how more advanced models from statistical research can help to structure and analyze current managerial challenges, especially in an environment where moderation and mediation occur together in the same model, when the treatment effect of an independent variable on the outcome variable via a mediator variable differs depending on levels of the moderator variable, as theorized by Preacher et al. (2007). This paper shows an example of where such analysis can be practically applied.

The data size of this study, due to the nature of the subject matter, is however with n=127 rather low and provides an opportunity for future research to validate the findings in a bigger sample size. Additionally, it could be envisioned to add additional hypothesis to the analysis, assuming that there are more drivers behind companies that have a leading edge on digitalization in areas such as digital affinity in general, outsourcing-degree, transparency needs, as well as trust in vendors, employees, processes, and systems. Interesting examples of what was unveiled in the survey but not yet included in the analysis is that 83% of participants expressed the desire in digital purchasing, while 21% don't see predictive analytics soon. Furthermore, a bigger data sample could be leveraged to analyze differences between the different industry segments. The data of this research indicates that capital goods industries are taking a leading role in respect to digitalization in supply chain and procurement, presumably because these have the biggest pain with dead capital of procured goods.

4 Structure or culture – How to digitize procurement

4.1 Introduction

Digital innovation is one of the main forces for improving and driving economic performance (Goerzig and Bauernhansl, 2018), digitalized products are transforming competition (Porter and Heppelmann, 2014) and digitized companies are outpacing their competition in the digital era (Westerman and Bonnet, 2015; Carr, 2009). These trends don't stop at the boarders of the procurement function, where digital tools promise new levels of procurement performance (De la Bouleye et al., 2017) and procurement practitioners experience a rapid pace of change and continued evolution of the procurement function (Daher et al., 2018). Procurement professionals therefore ask themselves how digitalization can improve the procurement function (Monahan, 2017). Practitioners see digital disruption and data explosion as main driving forces behind the need for companies to transform how they do business and move towards becoming an intelligent enterprise (Fersht et al., 2018) and procurement teams can take a leading role in shaping the company's digital strategy (Radell and Shannon, 2019). However, the dynamic and complex technology landscape with various fields of innovation and emerging technologies (Högel et al., 2018) creates uncertainty with regards to which technology to deploy for which use case and if technologies are already mature enough for productive deployment in practitioners' quest to rapidly and effectively digitalize procurement (Kosmol et al. 2019).

The motivation of this paper is threefold: first it demonstrates the relationship of the level of digitalization in respect to the entrepreneurial orientation and the organizational structure of the firm as well as the respective performance of the procurement function. Second, it provides insights for determining the level of digitalization in the procurement function, by outlining different areas of digitalization relevant for the procurement function as well as detailing a number of individual technologies currently available. Finally, it evaluates the impact of

different managerial approaches to foster digitalization and differentiates structural from cultural approaches. Structural approaches suggest a centralization of the procurement function in order to have a better handle on the technologies applied while cultural approaches rather imply a bottom-up business driven deployment of digitalization technologies. With this research new perspectives in explaining how digitalization can create a sustained competitive advantage for a firm's procurement function and how the different approaches impact the level of digitalization are provided, based on empirical data.

4.2 Digitalization of procurement

The possibility of investing in emerging and maturing digital innovations is extensive. For example, cloud computing is enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (Mell and Grace, 2011) and artificial intelligence is becoming available on a broad scale, providing software applications that are able to solve problems that would otherwise require intelligence when performed by people (Kurzweil, 1990). Looking specifically at the procurement function, technologies used in decision support systems today are ready to leverage new paradigms, such as predictive or prescriptive analytics (Maisel and Cokins, 2014). Further, sensor data from connected objects part of the internet of things can be leveraged to innovate new and advanced business processes (Zouganeli and Svinnset, 2009) and 3D printing enables small quantities of customized goods to be produced at relatively low costs with the potential to revolutionize manufacturing and to enable companies to operate with little or no unsold finished goods inventory (Berman, 2012). The list of examples of digitalization technologies could easily be continued (Rejeb, 2018).

Attracted by the effects these digitalization innovations promise, organizations are investigating possibilities to leverage them. However, the question as to how to start or continue the

digitalization journey and in which technology to invest in this dynamic and innovative environment is still a difficult one to answer. One of the challenges is to get an overview of available technologies and applications, but additionally the respective digitalization level and value contribution is not easy to be determined, especially since it depends on the individual situation and the environment in which it is evaluated. Ultimately, the level of digitalization depends on the general approach companies take towards business decisions.

Consequently, in order to define digitalization, a sound construct is required (Suddaby, 2010). Especially for assessing the level of digitalization of a selected domain, a comprehensive set of criteria is required (Bruin et al., 2005). The level of digitalization can then serve as an indicator of the potentials an organization can derive from a certain technology. Descriptive models can be used to assess the as-is situation and the current capabilities of an organization concerning a given set of criteria (Becker et al., 2009). The maturity of available technologies, where maturity implies a certain evolution and development of a system (Schumacher et al., 2016), is an important aspect as well. Conceptually, the level of digitalization can be evaluated from a number of dimensions, including organizational digitalization, data management, process digitalization and cross-enterprise digitalization:

In more detail, the concept of organizational digitalization pursued here is following the thoughts of Brynjolfsson and Hitt (2000) on how investments in information technology are linked to higher productivity and organizational transformation. This dimension looks at general purpose applications that enable organizations in general and in the context of this research the procurement function in specific to higher efficiency and effectiveness. Digitalization in terms of data management on the other hand involves technologies used from decision support systems, looking at data that is derived from on-line transactions processed (OLTP) and making them available for on-line analytical processing (OLAP) (Turban et al., 2014). Next, process digitalization consists of digitalization technologies supporting the

operational procurement processes (Lindemann and Schmid, 1998), specifically looking at special purpose applications leveraged in the direct and indirect materials sourcing process. And finally, cross-enterprise digitalization evaluates specific digital innovations in neighboring domains such as manufacturing, logistics or sales and service. These technologies are independent but have a strong relation to the procurement function. Table 5 provides an overview of existing technologies today, categorized by the four parameters outlined above.

Table 5: Selected digitalization technologies in procurement

Item	Description	Source	Parameter
Internal collaboration tools	electronic applications facilitating "collaboration among individuals engaged in a common task using electronic technologies"	Kock et al. 2001	Organizational digitalization
Cloud solutions	leveraging cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources	Mell and Grace 2011	Organizational digitalization
Supplier collaboration tools	in this context especially with the supplier base, as digital applications facilitating the collaborative planning, forecasting and replenishment process with suppliers	Fliedner 2003	Organizational digitalization
Direct materials sourcing solutions	supporting the whole product lifecycle from first product idea, product design, prototyping, series manufacturing, and after-market. This is a collaborative process involving sales, marketing, product development and manufacturing	Wolters 2002	Organizational digitalization
Artificial Intelligence	applied in a generic context and in the sense of digital applications that require intelligence when performed by people	Kurzweil 1990	Organizational digitalization
Master data management	a software solution that centrally manages all master data such as vendor master data or material master data for all systems of records	Dreibelbis et al. 2008	Data management
Transactional digital system of records	Enterprise Resource Planning tools used to collect, store, manage, and interpret data from procurement activities	Radovilsky 2004	Data management
Descriptive analytics	analytics based on own structured data in a dedicated solution such as an "Data Warehouse" to interpret, analyze and gain insights from historical data coming in from transactional systems	Devlin and Cote 1996	Data management
Predictive analytics	analytics based on big and unstructured data, employing modelling using statistical and machine learning techniques to predict future patterns based on historical data coming from own transactional systems as well as other sources which might contain huge business data that might not be structured in the same way	Waller and Fawcett 2013a; Maisel and Cokins 2014	Data management
Prescriptive analytics	analytics using optimization to identify the best alternatives to minimize or maximize some objective, considering the uncertainty in the data. Prescriptive analytics addresses questions like: How much should we procure to maximize profit? What is the best way of receiving goods to our factories to minimize costs? How should we change our plans if a natural disaster closes a supplier's factory?	Evans and Lindner 2012	Data management
OCR/scanning	a process where invoices are scanned for processing and archiving purposes, using a scanning device for paper-based invoices	Köppen et al. 1998	Process digitalization
Electronic Data Interchange	computer-to-computer interchange of strictly formatted messages that represent business documents, implying a sequence of the message structure between two parties	National Institute of Standards and Technology 1996	Process digitalization

Procurement self-services	self-services to increase operational procurement efficiency by enabling employees of a company to maintain and execute the respective procurement requisitions autonomously within given boundaries	Bradler and Mödder 2010	Process digitalization
Business networks	digital trading platforms connecting multiple corporate customers and suppliers with the purpose of facilitating the procurement activities	Ordanini 2005	Process digitalization
eCatalogs	Integrated eCatalogs that hold information about the goods and services offered by the participants of an electronic marketplace integrated in the buyer's procurement solution to automate and streamline indirect procurement processes	Kim et al. 2004	Process digitalization
eAuctions / eBidding	open and transparent e-business process between auctioneers and bidders, which takes place on an electronic marketplace in certain specified periods	Engelbrecht-Wiggans and Katok 2006	Process digitalization
Robotic process automation	tools automating the operational procurement activities such as monitoring an event, extracting data from files, performing checks against a defined set of criteria, making decisions based on predefined set of conditions, or sending confirmation emails	Willcocks et al. 2015	Process digitalization
Chatbots	Bots that engage in conversation with a human participant. In procurement this function is used for conversations between internal requestors and the procurement function as well as towards suppliers for actively clarifying incorrect invoices or answering questions.	Weizenbaum 1966	Process digitalization
Machine learning	methods of data analysis that automate analytical model building, as a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention	Siegel 2013	Process digitalization
Integrated IT systems	ideally harmonized towards a single core	Grossman and Walsh 2004	Cross-Enterprise
Sensor data / connected objects	as leveraged in "Internet of Things"-technologies that enable objects and infrastructure to interact with monitoring, analytics, and control systems over internet-style networks	Zouganeli and Svinnset 2009	Cross-Enterprise
3D Printing	enabling production of small quantities of customized goods at relatively low costs with the potential to revolutionize manufacturing and to enable companies to operate with little or no unsold finished goods inventory	Berman 2012	Cross-Enterprise
Smart contracts	leveraging digital means to control property rights	Szabo 1997	Cross-Enterprise
Blockchain	Distributed ledger technology as a concept consisting of the methods, technologies, and tool sets to support a distributed, tamper-evident, and reliable way to ensure transaction integrity, irrefutability, and non-repudiation. Blockchains are write-once, append-only data stores that include validation, consensus, storage, replication, and security for transactions or other records.	Konstantinos and Devetsikiotis 2016	Cross-Enterprise
Freight and logistics apps	providing mechanisms that auto-match the consignor's demand and the carrier's supply based on mobile Internet	Li and Yu 2017	Cross-Enterprise
Digital Twin	a technology to manage a virtual representation of a complex product, using the best available physical models, sensor updates, etc., to mirror the life of its corresponding physical twin	Glaessgen and Stargel 2012	Cross-Enterprise
Virtual / augmented reality	technologies for entirely virtual vision or in case of augmented reality for virtual overlay of information on real physical object to enable part identification and procurement processes of for example spare parts as part of a maintenance and repair process or others	Whyte 2003; Henderson and Feiner 2007	Cross-Enterprise
Autonomous self-driving vehicles / drones	for intra-plant and interplant transportation of for example scarce materials or to monitor the health of infrastructure	Lozano-Perez 2012 Waller and Fawcett 2013b	Cross-Enterprise

4.3 Conceptual framework

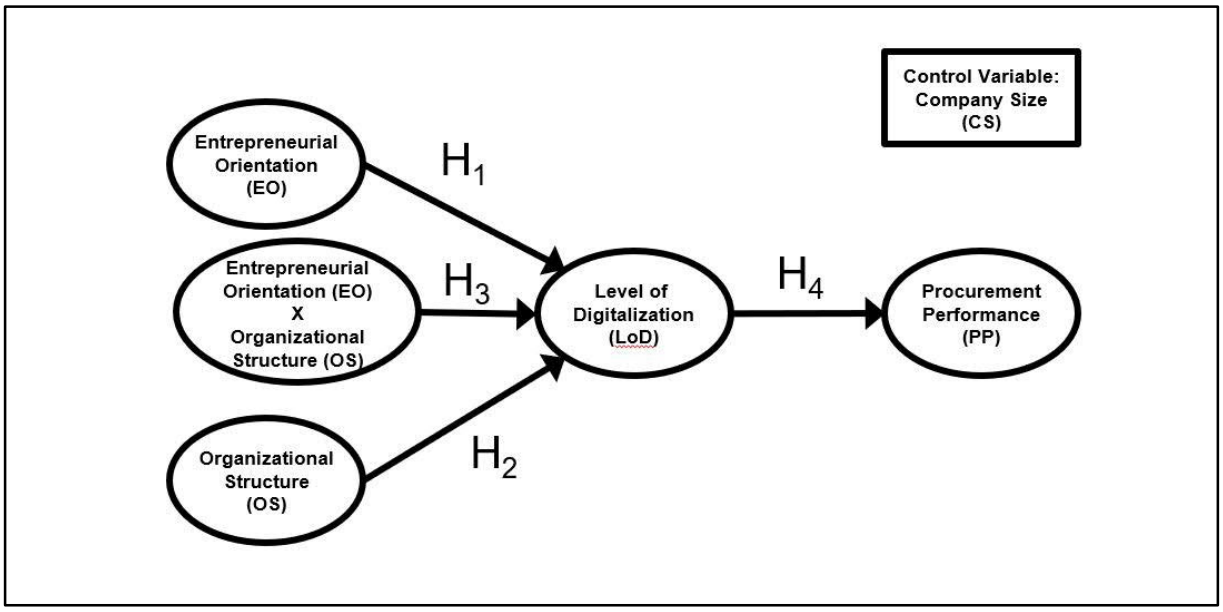
In order to analyze the sources of digitalization and to understand what potentially determines the level of digitalization of a firm's procurement processes this paper builds on the entrepreneurial orientation theory, one of the most widely accepted firm-level constructs in the literature (Wales et al., 2013). The assumption is that digitalization of the procurement function at the current maturity stage requires a significant level of innovation as well as other elements from entrepreneurial orientation such as risk-taking and proactiveness in order to be successful. Thus, speaking with the words of Steve Jobs: "Innovation distinguishes between a leader and a follower" it can be assumed that innovation is not limited to coming up with new brilliant ideas only but as well includes leveraging existing technologies in new contexts and creating new applications. In any case, being a true innovator means to do something different and better than anyone before and seeing new potentials (Wolfe, 1994). Consequently, one research question is if entrepreneurial orientation as representative of the concept of culture fosters digital innovation and the level of digitalization.

However, there might be other aspects beyond entrepreneurial orientation that have a strong impact on the level of digitalization. Digitalization of the procurement function could alternatively be regarded as rather a managerial task of executing the implementation of technologies in certain domains, without too much entrepreneurial or innovative aspects but rather aspirations towards scaling the use of technologies across the organization. To speak with the words of management consultants such as Peter Drucker: "You can't manage what you can't measure" a prerequisite to adoption of digitalization in this line of thought is to make the level of digitalization measurable. This means that the level of digitalization needs to be clearly defined and tracked across the organization, something which requires a more structured and centralized environment (Moch and Morse, 1977). Consequently, this paper analyzes if centralization of the procurement function as additional element to the entrepreneurial

orientation of the organizational structure fosters digital innovation and the level of digitalization.

Advancing the analysis of the digitalization of procurement processes, it is finally assessed if the effects of these two outlined variables of entrepreneurial orientation and organizational structure simply add up, contradict each other or have some other means of interplay by examining the interaction effect of the two. Figure 19 illustrates these conceptualized relationships.

Figure 19: Model of entrepreneurial orientation, organizational structure, level of digitalization and procurement performance



In two separate steps, the antecedents and the effects of the digitalization level in procurement are analyzed. The following subchapters are outlining the leveraged constructs in detail.

4.3.1 Antecedents to digitalization of procurement

Entrepreneurial orientation, that according to Rauch et al. (2009) has a great impact on a firm's overall performance, might as well have a significant impact on the investments in digitalization tools, thus the level of a company's digitalization. Research on entrepreneurial orientation and the relationship on firm performance is not new. The objective of the research around

entrepreneurial orientation is to determine the process by which organizations are renewing themselves by pioneering, innovating, and risk taking as outlined by Miller (1983). In literature multiple approaches to measure entrepreneurial orientation exist. The fundament of entrepreneurial orientation is suggesting that an entrepreneurial firm is one that "engages in product market innovation, undertakes somewhat risky ventures, and is first to come up with 'proactive' innovations, beating competitors to the punch" (Miller, 1983: 771). Applying entrepreneurial orientation to the procurement function, research shows that firms direct their strategic decisions and practices toward the pursuit of new opportunities to sustain difficult situations (Colvin and Slevin, 1989). Further linking the entrepreneurial orientation parameters to a firm's performance, strategy making processes, that provide organizations with a basis for entrepreneurial decisions and actions, have a relationship to a firm's performance (Lumpkin and Dess, 1996). Entrepreneurial orientation therefore facilitates a company's ability to identify new opportunities with potentially large returns, target premium customers, and obtain first-mover advantages (Lumpkin and Dess, 1996). There are numerous additional studies which provide empirical proof that entrepreneurial orientation has a positive impact on a firm's performance (Rauch, Wiklund, Lumpkin and Frese, 2009). However, there are as well some studies that show contradictions (e.g. Matsuno, Mentzer and Özsomer, 2002) and Wiklund and Shepherd (2005) give further indications as to how to improve the entrepreneurial orientation concept by adding additional organizational and environmental characteristics to the models. However, only limited research has focused on internal factors that affect successful alignment of entrepreneurial orientation inside an organization (Covin et al., 2006). Looking at the relevance of entrepreneurial orientation on the knowledge creation process, research shows the linkage of entrepreneurial orientation with technology in general (Li at al., 2009).

Therefore, advancing the entrepreneurial orientation theory, the following academic contributions to literature are made: the entrepreneurial orientation concept is applied to the

digitalization of the procurement function, an essential element of overall firms' performance, with supply management and procurement spend being a central variable in the equation of revenues and financial performance (Hallikas et al., 2011). Thus, the following hypothesis on entrepreneurial orientation and the overall digitalization degree is proposed:

Entrepreneurial orientation, as outlined before, consists of the corporate policies and practices that Miller (1983) separates into innovativeness, proactiveness, and risk taking. It is proposed that an entrepreneurial orientation facilitates the company's digitalization and investments in digitalization technologies and it is therefore postulated that the innovativeness, proactiveness and risk-taking attitude of professionals in a firm should lead to a higher level of digitalization, since investments in digitalization technologies as well requires an entrepreneurial approach towards innovation as well as proactiveness and risk-taking. Thus,

H1: More entrepreneurial orientation leads to a higher company's overall digitalization degree.

Next to the entrepreneurial orientation with the firm's professionals' risk-taking, proactiveness and innovativeness other central elements might be influencing the level of digitalization as well. Especially the degree of freedom of the acting organizations could potentially add to these entrepreneurial orientation attributes in their effect on the level of digitalization. A central determination on the level of freedom could be derived from one of the most essential organizational question firms are facing when looking at the organizational setup of their procurement function: whether to centralize or to decentralize the procurement department (Dimitri et al., 2006). McCue and Pitzer (2000) provide a definition of centralized and decentralized procurement functions in the context of the public sector, concluding that decentralization is becoming more and more attractive for governments. In environments with high regional and local specialties and a close relationship to the suppliers is required, decentralization might be beneficial, and effects of entrepreneurial orientation could be leveraged more efficiently. In other words, if the information about the purchased product is

localized and potentially even subject to national legislation, such as for example in real estate, the procurement should be decentralized. Dynamic markets or markets with frequent disruptions and high uncertainties are further indicators for decentralizing procurement decisions in order to gain speed in the decision-making process and reduce supply risks (Dimitri et al., 2006).

However, indirect procurement processes, like for example when procuring stationery or paper equipment, where the characteristics of the procured product are highly standardized, provide a good potential for increasing the degree of centralization. Same applies to networked economies, where the product offering is centralized as well via business networks, where centralized procurement increases the bargaining power of the procurement function.

Thus, since digitalization tools and technologies are more and more standardized on a global level, it is proposed that centralized procurement departments facilitate the level of digitalization in the procurement function as such. As argued before, market dynamics are existing in the field of digitalization tools, but not to an extent short that term decisions are counting and justifying local decision making. Finally, local information required is outpaced by the need for bargaining power.

Acknowledging Dimitri et al. (2006) that, in real world no perfect fully centralized or decentralized procurement setup exists, where procurement is either fully centralized with all relevant decisions are in the hands of a firms' headquarter or fully decentralized when divisions are delegated the power to decide how, what and when to procure, but hybrid models prevail, with a wide range of intermediate procurement models where central and local purchasing units share the power on purchasing decisions, it is postulated that

H2: Organizations with a more centralized procurement function have a higher degree of digitalization.

4.3.2 The interplay of entrepreneurial orientation and centralization

In a third dimension it is further investigated as to how the different effects from H1 and H2 interrelate. As postulated, entrepreneurial orientation as well as centralization of the procurement function could both be regarded as good approaches towards improving the level of digitalization and intuitively it seems reasonable to assume that both are simply additive effects increasing the level of digitalization. However, especially when looking at the entrepreneurial orientation dimension of autonomy, there exists a control versus empowerment dilemma (Lumpkin et al., 2009). In a very controlled, structured, and centralized environment entrepreneurial orientation may not be fostered and possibly contradicted. If e.g. measures and KPIs are centrally dictated, local decisions are less likely to be of entrepreneurial nature but more guided towards fulfilling and optimizing the measured KPIs. Thus, both elements are not necessarily applicable together. Therefore the two variables are compared to see how they interrelate, following the argumentation of Mintzberg (1994) as well as Love et al. (2002) and it is postulated that in case of doubt, entrepreneurial orientation is more efficient towards digitalization of the procurement function than the organizational structure effects of centralization. Centralization is the best approach to implement top down strategies and imply technology onto the different processes. However, in the case of digitalization it is believed that a bottom-up, local and business-need driven digitalization will be the more effective approach. Therefore, besides the hypnotized direct effects (H1 and H2) it is expected to observe a compensating interaction effect between the two managerial dimensions, thus:

H3: Entrepreneurial orientation compensates the effects of centralization in the impact on digitalization of the procurement function.

4.3.3 Effects of digitalization of procurement

Building on the transaction cost theory from Williamson (1985), explaining why the reduction of coordination costs will facilitate trading and strengthen the procurement function, anecdotal evidence suggests that digitizing the procurement function leads to higher performance: De la Bouleye et al. (2017) report from a large industrial company that was able to reduce its total air freight costs by 25 percent by using a commercially available multi-variable freight optimization solution. Högel et al. (2018) elaborate how an automotive manufacturer leverages descriptive analytics solutions to realize material cost savings of 5% to 10% on relevant spend volume by analyzing invoices and prices from previous years and unveiling suppliers' failure to provide appropriate volume discounts. In addition, Högel et al. (2018) explain how BMW, a German car manufacturer, is leveraging a virtual collaboration platform to develop new offerings jointly with their suppliers. Further, Radell and Shannon (2019) explain how a global industrial company established a collaborative data platform as single source of truth for all procurement data, such as contract records and savings opportunities, that was easily accessible by all business units and functions, generating transparency on savings and aligned decision making on budget processes. In addition, they report how an industry consortium including ship builder Maersk is piloting a collaborative project to test the potential for using 3D printing as an alternative to store spare parts for ships and offshore facilities (Radell and Shannon, 2019). To conclude, practitioners are convinced that digitalization leads to increased performance. At first glance, quantifying the value improved procurement performance delivers seems straight forward: In addition to improving operational efficiency, which can be measured through metrics such as decreased cycle times, percentage of on-time payments, and others, procurement generates cost savings that hit to the bottom line. However, determining the performance of the procurement function in general is a difficult undertaking, considering the heterogeneity of industries and processes involved (Schiele, 2007). Various research has been

conducted on the subject matter (Carr, and Smeltzer, 1999; Shin et al., 2000; Carr and Pearson, 2002) but determining the procurement efficiency remains a subjective judgement matter, especially since measuring and understanding the value of procurement extends simply monitoring operational efficiency metrics and identifying cost savings but needs to be separated between the procurement department, the related business functions and the office of finance. Further, to determine what should be categorized as cost avoidance or what qualifies as negotiated savings, a very detailed analysis is necessary. For example, procurement could negotiate more favorable payment terms to improve its performance in relation to the company's working capital position, but procurement could also contribute to operational improvements that increase the working capital efficiency by establishing a just-in-time delivery model with a certain supplier, reducing overall inventories. Thus, in absence of an absolute measure for the value procurement is driving and the according procurement performance, and acknowledging the dynamics this topic is subjected to, the overall performance of procurement is measured related to the benchmark of the main competitor in order to get a valid construct (Pelham and Blanton, 2012). Thus, the following hypothesis on overall digitalization degree and procurement performance is proposed: The overall digitalization degree has a positive impact on the firm's procurement performance. The procurement performance is measured by the effectiveness of the procurement function in supporting the overall companies targets. The effectiveness of the procurement function includes several aspects: the reduction of the total spend resulting in a higher financial performance of the company in the equation where revenues reduced by spend resulting in the company's financial results. In addition, the procurement effectiveness can be measured by spend managed per procurement employee or other metrics. On these terms, digitalization, as outlined before, can also help a firm to produce and deliver products or services to customers at lower cost and higher speed through the improvement in coordination between supply chain partners (Lin et al., 2002). Thus,

H4: More digitalized companies have a better procurement performance.

In the following a regression analysis is applied on the model of entrepreneurial orientation, organizational structure, overall digitalization level and procurement performance, showing the effects of entrepreneurial orientation and organizational structure and it's combination on the overall digitalization degree as well as the effect of the same on the procurement performance.

4.4 Research Method

4.4.1 Data

The foundation of this study is a survey that was conducted in 2019 and targeted at executives in procurement and supply chain management functions. More than 3000 individuals across the globe were contacted, generating a qualified data pool of 335 data sets, with a response rate of roughly 11%. In order to have comparable data, only complete data sets are taken that fulfill qualitative criteria in terms of duration of answering time as well as variance in the answers. The resulting sets are further reduced by sets of companies with less than 100 employees, assuming that companies must exceed this threshold to have significant budget and system as well as process requirements to benefit and evaluate digitalization tools towards the expected value drivers as outlined above.

The respondents belong to various industries, which are broken down into the following clusters, per respective purchasing characteristics: Cluster asset intensive industries, that include chemicals, oil and gas, healthcare, and life sciences as well as telecom and media. These industries are characterized by high requirements towards infrastructure and machinery investments. Consumer goods industries cluster, that includes consumer products and retail industries, that have a B2C orientation and relatively short product life cycles, thus dynamic requirements towards suppliers. Cluster capital goods industries includes automotive, industrial products, manufacturing, high tech and software. These industries are B2B orientated and have

relatively long product life cycles, meaning less dynamics in terms of supplier requirements. The service industries cluster includes financial services as well as travel and logistics. From a procurement perspective, these industries are characterized by predominantly indirect product requirements. Finally, public sector, a highly regulated cluster that follows specific patterns with regards to procurement, especially looking at annual spend budgets and the like. The overall distribution of the respondents per industry is shown in Table 6.

Table 6: Industry distribution of data sample

Cluster	Industry	n	%
Asset	Chemicals / Oil & Gas	37	11
Asset	Healthcare / Life Sciences	26	8
Asset	Telecom and Media	13	4
Consumer	Consumer Products & Retail	33	10
Capital	Automotive	18	5
Capital	Industrial Products	24	7
Capital	Manufacturing	38	11
Capital	High Tech / Software	47	14
Service	Financial Services	16	5
Service	Travel, Transport & Logistics	17	5
Public	Public Sector	13	4
Other	Other Industries	53	16
Total		335	100

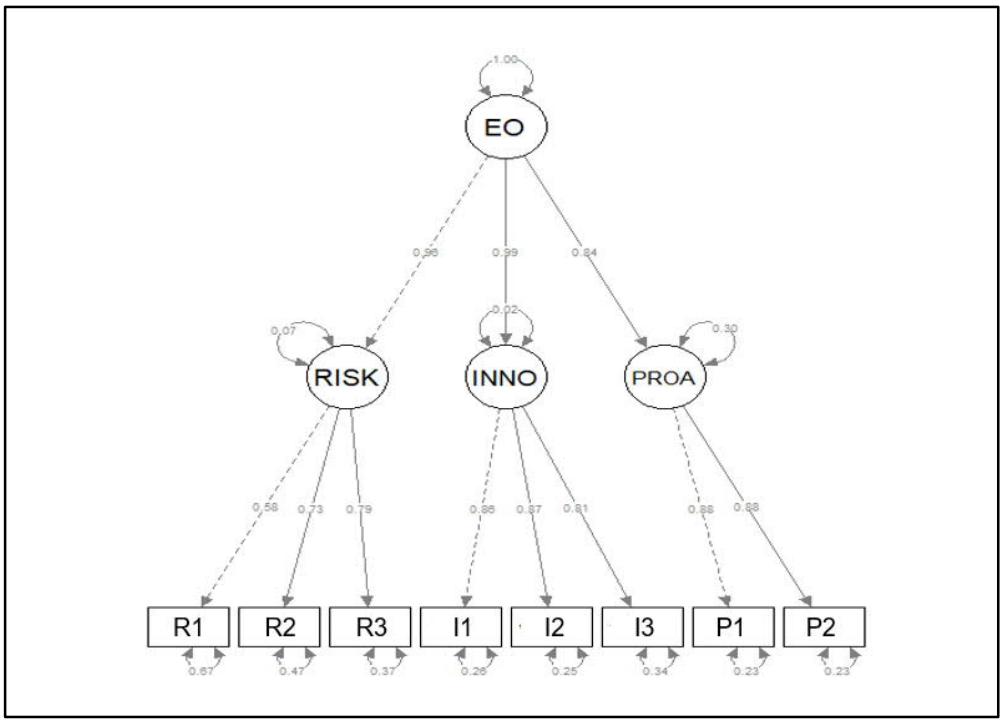
Another dimension regarding the characteristics of the respondents is the geography. In the survey respondents are coming from an international background and all mayor regions, including North and South America (25%), Europe (67%) and Asia Pacific (8%).

4.4.2 Measures

For the analysis four central measures are used: Entrepreneurial Orientation (EO), Organizational Structure (OS), Level of Digitalization (LoD) and Procurement Performance (PP). Wherever possible, established measures from earlier research are leveraged, a practice suggested by Churchill (1979). For EO the scale developed by Engelen, (2010) is used. Here, entrepreneurial orientation is measured as a second order reflective construct, consisting of the three components risk-taking attitude (measured with three items), innovativeness (measured with three items) and proactiveness (measured with two items). High values indicate higher

levels of entrepreneurial orientation. For OS, Krause (1995) was followed using a single item variable for identifying the centralization degree of the company. High values indicate higher levels of centralization. For measuring LoD two central variables are used in order to keep the model as lean and transparent as possible: on the one hand an evaluation of the digital maturity of the procurement function and on the other hand a self-assessment of how digitalization technologies are leveraged in the organization overall. High values indicate high level of digitalization. PP is measured with a single item, looking at how the individual is judging the performance of its procurement function overall in comparison to the major competitor. High values indicate high level of procurement performance. As control variable company size is used. This variable is derived from a specific question asking for the number of employees in the organization of analysis.

Figure 20: Model of second order reflective construct for EO



Confirmatory factor analysis (CFA) is used to validate the EO construct. To this end, all three latent variables (risk-taking attitude, innovativeness, proactiveness) are included in a single multifactorial CFA model which is tested (using the package *lavaan* in *R*) with raw data as the

input matrix. The three latent variables are then modeled as reflective components of EO as a second-order reflective construct as visualized in Figure 20. Given that some indications for the presence of multivariate non-normality are found, the model is estimated using the robust maximum likelihood estimation method. Based on common recommendations for models of comparable size (e.g., Hair et al., 2014), the associated goodness-of-fit indices demonstrate that the sample data fit the hypothesized model very well: ($\chi^2_{(df = 17)} = 70.23$, $p < 0.001$; $\chi^2/df = 4.19$, CFI = 0.95, TLI = 0.92, SRMR = 0.039, RMSEA = 0.098 with 90% confidence interval = [0.078; 0.118])[2]. Details of the measurement model appear in Table 7.

Table 7: Confirmatory factor analysis of reflective constructs

Measures and associated indicators	Coefficient alpha	Average variance extracted	λ	*SE*	*t*-value[a]	R^2
Risk-taking	0,74	0.49				
Please indicate how your firm compares to your competitors? (1: Strongly agree – 5: Strongly disagree):						
(R1) Our firm stresses a fully delegated policy for employees.			0.576	–[b]	–[b]	0.33
(R2) Our firm gives the freedom for individuals or teams to develop new ideas.			0.724	0.110	10.590	0.52
(R3) In general, the top managers of our firm have a strong tendency to be ahead of others in introducing novel products or ideas.			0.791	0.138	10.416	0.63
Innovativeness	0,88	0.71				
Please indicate how your firm compares to your competitors? (1: Strongly agree – 5: Strongly disagree):						
(I1) Our firm encourages and stimulates technological, product/service-market, and administrative innovation.			0.848	–[b]	–[b]	0.72
(I2) Our firm stimulates creativity and experimentation.			0.859	0.04	25.235	0.74
(I3) Our firm's innovative initiatives are hard for competitors to successfully imitate.			0.814	0.06	18.019	0.66
Proactiveness	0,77[c]	0.77				
Please indicate how your firm compares to your competitors? (1: Strongly agree – 5: Strongly disagree):						
(P1) In dealing with competitors, our firm typically initiates actions which competitors respond to.			0.876	–[b]	–[b]	0.77
(P2) In dealing with competitors, our firm is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.			0.877	0.062	17.473	0.77

Note. All items were measured on five-point rating scales (Likert-type). λ refers to standardized factor loading and *SE* to standard error (asymptotically robust estimate).

[a] *t*-values and standard errors are from the unstandardized solution. All factor loadings are significant at the $p < 0.001$ level (two-tailed).

[b] Factor loading was fixed at 1.0 for identification purposes.

[C] Bivariate Correlation Coefficient (Pearson)

[2] CFI refers to comparative fit index; TLI refers to Tucker-Lewis index (also non-normed fit index , NNFI); SRMR refers to standardized root mean square residual; RMSEA refers to root mean square error of approximation.

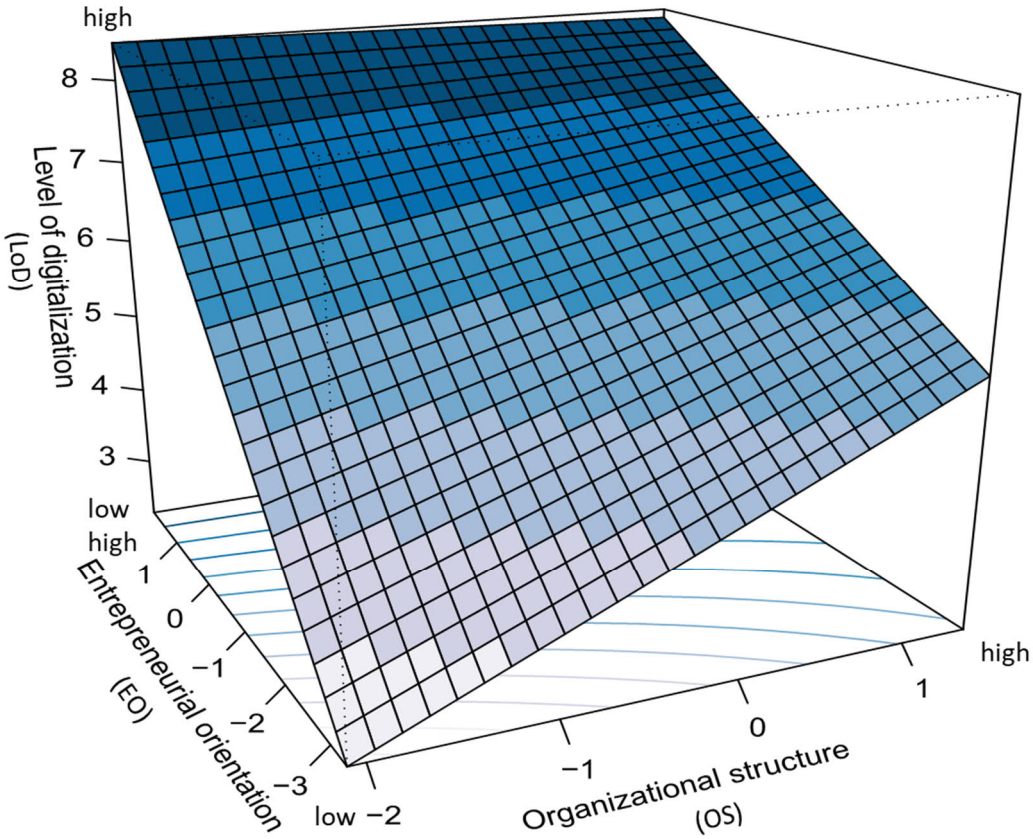
4.5 Analysis and results

In order to identify the significant relationships in the model outlined before a regression analysis is conducted. For analyzing the linear relationships of the model, ordinary-least squares (OLS) regression analysis is applied, assuming that the underlying OLS estimates are met (Cohen 2010). This analysis shows no reasons that the chosen estimation approaches are inappropriate. In order to increase the confidence in the analysis despite the relatively small sample size, bootstrapping is applied, with 100.000 random samples.

In the first hypothesis it is postulated that companies with high entrepreneurial orientation show a high level of digitalization (H1). The results from the analysis, as outlined in Table 8, support this hypothesis with a significant strong effect of EO on LoD (standardized regression coefficient = 0.83, $p < 0.001$). Further, in the second hypothesis it is postulated that companies with a centralized organizational structure have a higher level of digitalization as compared to companies with a decentralized procurement organization (H2). As well, this hypothesis is supported by the analysis with a significant positive effect of OS on LoD (0.29, $p < 0.01$). Consequently both, H1 and H2, are supported.

Next, looking as to which effect is dominating the relationship of EO and OS on LoD, assuming EO compensates the effects of OS as postulated in H3, it can be shown that EO has a much higher impact on LoD compared to OS. This holds true for all levels of OS. However, especially at high levels of EO it can be observed that OS has almost no impact on LoD, supporting H3. These effects cannot be shown with the linear regression analysis only but require a visualization on a 3D interaction plot, where the effects can be separated along multiple dimensions as shown in Figure 20.

Figure 21: 3-dimensional interaction effect plot: Entrepreneurial orientation × organizational structure on the level of digitalization



In this figure 21 it can be seen that the positive correlation between EO and LoD is not changed, but simply flattened when increasing the organizational structure towards more centralization. At low levels there is a very clear effect to be seen, but even at high levels the effect is still obvious. On the contrary, when looking at the correlation of OS and LoD, the effect is significant at low levels of EO, but almost neutralized at high levels of EO.

Consequently, a high entrepreneurial orientation helps companies to develop a high level of digitalization. Only at low levels of entrepreneurial orientation, centralizing the procurement organization significantly helps improving the level of digitalization. Further, the interpretation of the data shows that at high levels of OS, EO does not positively impact LoD. In other words, when centralization is too high, entrepreneurial orientation does not help improving the level of digitalization

Finally, when analyzing the second model looking at the impacts on the procurement performance, the assumption is that the overall digitalization degree has a positive effect on the procurement performance as well (H4). The results from the analysis of this model support this hypothesis with a significant positive effect of LoD on PP (standardized regression coefficient = 0.24, $p < 0.001$). This proves that the level of digitalization does have a strong impact on the companies' procurement performance, supporting H4. In addition, by controlling the model with the company size, it is shown that CS has no significant impact on either LoD or PP. Table 8 summarizes the results of the regression analysis. In square brackets the results of the bias-corrected and accelerated bootstrap confidence intervals are shown.

Table 8: Regression analysis

	Model 1		**Model 2**	
Variables	**Level of Digitalization (LoD)**		**Procurement Performance (PP)**	
Constant	6.90 ***	[6.71; 7.10]	3.30 ***	[2.80; 3.80]
	(0.10)		(0.23)	
Company Size (CS)	0.14	[-0.07; 0.35]	0.05	[-0.07; 0.18]
	(0.10)		(0.06)	
Entrepreneurial orientation (EO)	0.83 ***	[0.63; 1.04]	0.38 ***	[0.22; 0.54]
	(0.10)		(0.07)	
Organizational structure (OS)	0.29 **	[0.06; 0.52]	0.20 ***	[0.09; 0.32]
	(0.10)		(0.06)	
Entrepreneurial orientation × Organizational structure	–0.18 *	[-0.37; 0.01]		
	(0.09)			
Level of digitalization (LoD)			0.24 ***	[0.18; 0.31]
			(0.03)	
R^2	0.24		0.39	
Adj R^2	0.23		0.38	
F	25.43 ***		52.03 ***	

Note. $n = 335$. Bootstrapped 95%–confidence intervals (100,000 samples, BCa) are shown in brackets.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed, based on robust standard errors).

4.6 Discussion

With this research it is shown that digitalization in procurement is happening more in organizations that show a high entrepreneurial orientation, thus the empirical evidence from the entrepreneurial orientation research can as well be applied to investments in digitalization technologies. A similar effect is supported when the organizational setup is structured in a centralized way, allowing leaders in procurement functions a better handle to organizational decisions, especially with regards to investments in digitalization tools.

From a managerial point of view this is a strong case for centralization of procurement as well as fostering entrepreneurial orientation in that domain. However, in case of doubt there is a very clear indication that cultural aspects beat structural elements. Fostering an entrepreneurial culture has a bigger impact on the level of digitalization than centralizing the procurement function. However, changing the entrepreneurial orientation of the organization might prove more difficult, at least short therm. Practitioners need to respect the given entrepreneurial orientation in a first place and can only foster a cultural change towards a higher entrepreneurial orientation which will take significant time. Changing the organizational structure on the other hand could be easier and show results quicker. In the long run however, this survey implies that cultural changes towards a bottom-up local entrepreneurial culture will show better results for the level of digitalization and consequently the procurement performance. Consequently, a mixed approach of combining centralization as well as cultural changes could prove the best strategy to increase the level of digitalization quickly and sustainably. In addition, it is found in the survey, that the main goals of digitalization initiatives thrive to automate processes (91% of respondents), achieve cost savings (68%) and improve data quality (67%). Major road blockers to increase the level of digitalization are reported to be in the areas of budget restrictions (46% of respondents), missing analytics and data insights (44%) as well as shortage of internal (46%) and external talent (25%) in the procurement domain. In a further drill down into the different

digitalization technologies building on Schumacher et al. (2016), emerging and mature technologies are identified. More than 50% of respondents report the usage of cloud solutions, collaboration tools, systems for master data management as well as transactional systems of record, OCR and scanning solutions, EDI, procurement self-services, business networks and e-catalogs. Conclusively these technologies are assumed to be reaching maturity already or any time soon. Technologies such as artificial intelligence, prescriptive and predictive analytics, machine learning, chatbots, 3D printing, digital twin or blockchain on the other hand seem to be rather evolving yet. These technologies are reported by less than 20% of respondents to be leveraged productively at the time of asking. Finally, the data shows a very disperse distribution of digitalization deployments along the industry verticals with certain industries having a stronger relationship towards dedicated technologies than others. For example, emerging technologies such as artificial intelligence, predictive analytics or chatbots and robotic process automation are more leveraged in the high tech and software industry while 3D printing is related to manufacturing industries predominantly. The automotive industry shows the strongest deployment of digital twin technology and financial services companies deploy blockchain technologies the most. Possibly this shows that the industry in which certain technologies originated are the ones where the value is most transparent or in the case of high tech and software, organizations simple have more insight into the value levers of the technology. Consequently, different industry verticals seem to have some homework to do in order to be able to harvest the potentials of technologies not originating from within their own domain. The data collected in the current survey is not sufficient to provide a details cluster analysis of the various industries and to give empirical evidence, but at least with regards to the overall digitalization and within the model 1 outlined above, the asset centric industry cluster with 76 data points is identified to show a very robust behavior along the hypothesis outlined above. In this subgroup, model 1 explains more than half of the variance with entrepreneurial

orientation as well as organizational structure, showing even more clear effects towards the level of digitalization.

4.7 Conclusion

It is demonstrated with this research, that the level of digitalization depends on the procurement professional's entrepreneurial orientation and the organizational structure of the company with respective centralization of the procurement function. Further, it is shown that the respective performance of the procurement function is impacted by the level of digitalization. This research provides insights for determining the level of digitalization in the procurement function by outlining different areas of digitalization relevant for the procurement function as well as detailing a number of individual technologies currently available, clustering those in emerging and mature technologies. This research provides perspectives on explaining how digitalization can create a sustained competitive advantage for a firm's procurement function and which environmental attributes in terms of entrepreneurial orientation and organizational structure foster the level of digitalization. This contribution helps on one hand practitioners to provide a good environment and give guidance as to follow either cultural or organizational strategies for digitizing the procurement function, on the other hand it provides empirical evidence for researchers to build on when developing further models and hypothesis on how digitalization matters for procurement.

Future research could be focusing on further identifying impacts technologies or technology clusters have on the overall digitalization as well as the procurement functions' performance. This research is focused on the aspects of digitalization as such, looking at the various dimensions of digitalization and the respective environmental factors. However, additional insights could be generated by drilling further down into the ascendants and effects of the digitalization of procurement, namely the organizational aspects as well as the performance variable.

5 Conclusion and Outlook

5.1 Summary

Digitalization remains a key theme in the area of procurement today and will continue to be in the near future. As outlined in this research, the trends are manifold and touch all elements of procurement, from operational as well as strategic perspectives. While the strategic procurement function needs to leverage digitalization to contribute to the company challenges as a business value enabler impacting the top line, digitalization is seen as key in streamlining operational procurement towards contributing to the bottom line as well.

This research provides a detailed analysis of B2B business networks market and the direct potentials that can be derived from them, including numerous areas where predictive procurement insights can be potentially harvested from B2B business networks. The potential advantages of leveraging B2B business networks in operational procurement scenarios focus on the area of cost reduction through the elimination of manual processes especially on the consumer side, and on leveraging efficiencies in supplier relationships and enabling supplier self-services. In addition, it is demonstrated leveraging a couple of concept design examples, how insights from B2B business networks could in addition help to improve the strategic side of procurement, by providing data for processes such as the supplier selection or contracting as well as financial elements.

The mechanics of participating in electronic B2B business networks are further analyzed with regards to motivation, opportunity, and ability to leverage digitalization. Based on the research of B2B business networks it is shown how digitalization in procurement is happening in areas with high competition and the corresponding need for efficiencies, but only in the case that underlying procurement processes are already digitized. The analysis shows how investments in B2B business networks act as facilitator of digitizing the procurement processes in order to

benefit from digitalization. The effect is even stronger if the existing technology is perceived as mature. Thus, investments in process and technical aspects are required to increase both, digital readiness on process level as well as digital maturity on technical level. For application in practice, it is outlined how companies need to differentiate between two fundamental aspects of their current situation with regards to procurement processes, assuming they are in a competitive environment and want to increase the level of digitalization in their processes. To increase the digital maturity, companies need to invest in educating themselves by investigating tools and solutions available on the market. To increase the digital readiness, initiatives and investment allocations need to go into reengineering and digitizing the fundamental procurement processes, for example by leveraging B2B business networks and subsequently artificial intelligence or machine learning. Investments in the later are especially beneficial if digital maturity perception is already high, otherwise there is a risk of inefficient resource allocation. This research demonstrates how the MOA-Framework can be applied to complex questions in operations management functions, helping to structure the different parameters of the research challenge and show the implications of parameters towards the general research question: How does motivation, opportunity and ability drive digitalization in procurement? The mediation-moderation framework is leveraged to apply the MOA framework to this research question, with very tangible and actionable results.

Next, digitalization is taken to a broader level, taking additional digitalization technologies into the picture and analyzing the digital maturity of a number of technologies and the readiness of the consuming company with the respective impact on procurement performance, drawing from the entrepreneurial orientation theory. It is shown that digitalization in procurement is happening more in organizations that show a high entrepreneurial orientation, thus the empirical evidence from the entrepreneurial orientation research can as well be applied to investments in digitalization technologies. This effect is especially supported when the organizational setup is

structured in a centralized way, providing leaders in procurement functions with a better foundation, upon which to make organizational decisions, especially with regards to investments in digitalization tools. This strong case for centralization of procurement is combined with the finding that fostering entrepreneurial orientation in procurement proves to be beneficial. In addition, the survey validates the initial assumptions, that the main goals of digitalization initiatives are to automate processes, achieve cost savings and improve data quality, which are all elements that support operational procurement functions. Next, and very relevant for the findings from the second study, is a further drill down into the different digitalization technologies to identify emerging and mature ones. Due to the fact that more than 50% of respondents reported using cloud solutions, collaboration tools, systems for master data management as well as transactional systems of record, OCR and scanning solutions, EDI, procurement self-services, business networks and e-catalogs, it is concluded that these technologies have reached maturity already or will do so any time soon. Therefore, building on the findings before, these technologies are ideal candidates to start the digitalization journey. In contrast, technologies such as artificial intelligence, prescriptive and predictive analytics, machine learning, chatbots, 3D printing, digital twin or blockchain are perceived as evolving. Less than 20% of respondents reported leveraging these technologies productively today. Consequently, these technologies need to be evaluated carefully before investments take place. However, the data shows a very disperse distribution of digitalization deployments along the industry verticals and certain industries have a stronger relationship towards specific technologies than others. For example, emerging technologies such as artificial intelligence, predictive analytics or chatbots and robotic process automation are more leveraged in the high tech and software industry while 3D printing is predominately related to manufacturing industries. The automotive industry shows the strongest deployment of digital twin technology whereas financial services companies deploy blockchain technologies the most. This shows that there are strong implications from the industry environment in terms of maturity perception and

decisions on where to invest need to be considered in this regard. In addition, different industry verticals might have experience some more foundational learnings in order to understand the potentials of technologies not originating from within their own domain. This could be a prerequisite in order for them to be able to benefit from these. In any case, this research demonstrates that the level of digitalization depends on the procurement professional's entrepreneurial orientation and the organizational structure of the company with respective centralization of the procurement function. Ultimately and most importantly this research shows that the respective performance of the procurement function is positively impacted by the level of digitalization. Furthermore, this research provides insights for determining the level of digitalization in the procurement function by outlining different areas of digitalization relevant for the procurement function as well as detailing a number of individual technologies currently available, clustering those in emerging and mature technologies as a fundament for the MOA analysis.

5.2 Limitations

The research approach chosen, including the conceptual foundation, the framework research and the two empirical studies, has several limitations. There are prerequisites to be fulfilled and environmental aspects to be considered for valuable and significant predictive procurement insights to become reality. The data basis of the fundamental B2B business network must be big and rich enough to provide meaningful insights, not only on a global level but also when drilling down into certain aspects of the business according to dedicated categories and geographies. Thus, the predictive procurement insights require an extensive usage of the trading platform for operational procurement activities, a prerequisite which most probably can only be fulfilled by a few operators in that field and only from operators covering a broad spectrum of spend categories across a broad customer community. Furthermore, the topic of privacy is

very crucial for the data provider to observe. Privacy standards need to be strictly obeyed by any B2B business network provider when generating predictive procurement insights or other value derivates from the data they obtain. At a minimum, these operators will need to make sure that the terms of use are known by their customers and ensure that they are permitted to use the data within the boundaries outlined above. When considering the key findings of chapter 3, it will be important for the investors to get clarity on the maturity of the numerous digitalization possibilities available on the market, an element which is highly dependent on the industry vertical as well as the geography of the observer and, as such, not easy to judge. This judgment however is a prerequisite for the investment decision, which should be directed initially to mature technologies to obtain sustainable investments in the digitalization applications. As with most empirical studies, the data size of this study is with n=127 rather low, especially when trying to drill down in individual industry verticals and geographies and getting insights on these dimensions. Similar limitations apply to the data collected in chapter 4. The data in this survey is not sufficient to provide a detailed cluster analysis of the various industries and to provide empirical evidence. Clustering the industry vertical along the asset centric industry cluster with 76 data points shows a very robust behavior along the hypothesis outlined above. In this subgroup, entrepreneurial orientation, as well as the organizational structure, shows even clearer effects with regards to the level of digitalization, but certainly more data points could help to explain more granular environmental aspects, by looking deeper into this industry cluster as well as providing insights into other industry segments.

5.3 Outlook

Digitalization in procurement is a journey that just has started. The biggest changes are yet to come. What is possible with technology today or visible on the technology horizon is just the beginning of the transition of business in general and specifically in procurement. Looking at

the potentials of B2B business networks and all the prerequisites in terms of data acquisition and privacy as well as economies of scale and network effects to be expected in that domain, it is clear that the parameters to obtain the expected levels of efficiency in operational procurement as well as predictive insights from the transactional data for strategic procurement functions are not easily fulfilled. It might take another couple of years of consolidation and experience in the field until this finally becomes a reality. A pragmatic approach for network providers and practitioners would be to leverage the data in a stepwise manner and to introduce the predictive and more advanced concepts incrementally. From an academic perspective, it would be prudent as a first step to analyze the data of B2B business networks in internal pilots in research collaboration with companies that are experienced in the field of data analytics and predictions, without monetization and with a limited focus. The learnings and insights gained from these pilots could then be used to highlight the benefits and be shared jointly with the updated usage term contracts, encouraging further participants to opt-in. The field of predictive analytics is broad and there is much to learn throughout the journey. Further research should therefore select a promising field of predictive procurement insights of B2B business networks and construct an example based on the data available to showcase the potential in a real-world case study or lab environment. Privacy concerns will continue to exist, and it will be crucial to address them in every pilot and with every iterative approach in this domain.

Another opportunity for future research could be to increase the empirical ground of the second study, so that the findings can be validated in a bigger sample size. Additionally, adding more hypotheses to the analysis would be prudent, assuming that there are more drivers behind companies that have a leading edge on digitalization in areas such as outsourcing-degree, transparency needs of the industry, as well as trust in vendors, employees, processes, and systems. Furthermore, a bigger data sample could be leveraged to analyze differences between the different industry segments, getting rid of some of the limitations outlined before. The

available data indicates that capital goods industries are taking a leading role in respect to digitalization in supply chain and procurement, presumably because companies in this segment have the biggest need for efficient capital deployment, but potentially there is much more to be unveiled.

Finally, the third study provides perspectives on explaining how digitalization can create a sustainable competitive advantage for a firm's procurement function and discusses how the environmental attributes, in terms of entrepreneurial orientation and organizational structure, foster the level of digitalization. However, it will be interesting to observe how technologies mature and become a commodity for all market participants and therefore become increasingly less attractive with regards to the potential for companies to leverage them to attain a competitive advantage. Future research could therefore focus on identifying how technologies impact the overall digitalization as well as the procurement functions' performance. This research is focused on the aspects of digitalization as such, looking at the various dimensions of digitalization and the respective environmental factors. However, additional insights could be generated by drilling further down into the ascendants and effects of the digitalization of procurement, namely the organizational aspects as well as further operationalizing the performance variable.

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Appendix

The following table provides on overview of the company profiles analyzed as part of this research:

Company	Company Facts and Figures	Web
Achilles	Headquarters in UK. Founded 1990 in Norway focusing on EMEA region with strong vertical focus (Oil&Gas, Automotive, Utilities). Partnering with Ariba	www.achilles.com
ADP	Headquarters in New Jersey, US. Founded in 1949; public owned (ISIN US0530151036) and partnering with OB10; DO2 technologies was acquired by ADP in Jan 2010. Originally focused on HR services and expanding into automotive sector as well as Oil and Gas	www.adp.com
Alibaba	Headquarters in Hangzhou, China. Founded 1999 with IPO in New York in September 2014. Offering manufacturing solutions based on RFQs or from the shelf predominately from mainland china to the world. ISIN US01609W1027	www.alibaba.com
Amazon Business	Headquarters in Washington, US. Founded 1994. Public since November 1997 (ISIN US0231351067). In 2015 announcing Amazon Business with a tailored business offering	www.amazon.com
Ariba	Headquarters in California, US. Founded 1996, since 2012 a SAP subsidiary (ISIN DE0007164600) Continuously enhancing the offering with other companies such as Fieldglass and Concur to cover additional market segments	www.ariba.com
Basware	Headquarters in Finland, Founded 1985 with IPO in Feb 2000 (ISIN FI0009008403) and acquisition strategy as well as partner strategy (e.g. with Bravo Solutions and Lavante)	www.basware.com
Bottomline Technologies	Headquarters in Portsmouth, US. Founded 1989 and public (ISIN US1013881065) with acquisitions strategy (SMA Financial - a Swift Provider and Bank of Americas Paymode	www.bottomlinetechnologies.com
Capgemini IBX	IBX, headquartered in Stockholm, Sweden was founded in 2000. Later takeover by Capgemini (ISIN FR0000125338)	www.capgemini.com
Coupa	Headquarters in California, US. Founded 2006. Owned predominantly by founders and venture capitalists with partnering strategy	www.coupa.com
Descartes	Headquarters in Canada. Founded 1981. Global reach, public (ISIN CA2499061083). Partnering with SAP	www.descartes.com
Deem	Headquarters in San Francisco, US. Founded 2000; acquired ketera in 2010	www.deem.com
E-Procurement Technologies	Headquarters in India, privately held niche player focusing on government agencies at all levels in India	www.abcprocure.com
E2Open	Headquarters in California, US. Founded in 2000. Newly shaped network combining on-premise planning with ICON-SCM solution and E2open business network. Recent IPO (ISIN US29788A1043)	www.e2open.com
eBay Business	Headquarters in California, US. Founded 1995. Ebays B2B offering from ebay platform. Public (ISIN US2786421030)	www.business.ebay.com
Elemica	Headquarters in Philadelphia, US. Founded in 2000. Global presence covering on-premise solutions as well as operating a network for process industries	www.elemica.com
GT Nexus	Headquarters in California, US. Founded 1999. Focusing on manufacturing and retail industries and logistics and other service providers. Takeover by Infor in Summer 2015	www.gtnexus.com

Hubwoo	Headquarters in France. Founded 1999. Public (ISIN FR0004052561) business network connecting to existing ERP solutions at the client side. Takeover bid from Perfect commerce as of June 2015	www.hubwoo.com
IBM	Subdivisions of IBM: (ISIN US4592001014) Emptoris Contract Management for procurement contract management aspects and sterling commerce in selling aspects	www.ibm.com
Invoiceware	Headquarters in Atlanta, USA. Founded 2008 by ex-Crossgate and Seeburger employees	www.invoiceware.com
Ivalua	Headquarters in France. Founded in 2000, privately owned global provider of spend management solutions with focus on the suite and cloud solutions.	www.ivalua.com
Lavante	Headquarters in San Jose, USA. Founded in 2001. Privately held by venture capitalist with funding from Venrock and ATA Ventures in 2009 and SAP Ventures. Partnering with Basware and Winshuttle	www.lavante.com
Liaison	Headquarters in US. Founded in 2000. Acquisition strategy around purchases of ADX, nuBridges and Hubspan	www.liaison.com
Mediagrif Interactive	Headquarters in Canada. Founded 1996. Public (ISIN CA58445U1049) running several e-commerce platforms	www.mediagrif.com
Mercado Eletronico	Headquarters in Brazil. Founded in 1994. Offering a transaction network with geographical niche focus on Brazil and Portugal	www.mercadoeletronico.biz
MFG.com	Headquarters in Georgia, US. Founded 1999. Presence in Americas, Europe and Asia and websites in English, French, German, Spanish and Italian	www.mfg.com
OpenText/GXS	Headquarters in Canada. Founded 1991.IPO 1996 (ISIN CA6837151068) Today conglomerate of acquisitions in different fields including info exchange with B2B / EDI communication hubs like Captaris, Hummingbird, Easylink and GXS	www.opentext.com
Perfect Commerce	Headquarters in US. Founded 1994. Full service provider for business network activities. Acquired the remainder of Commerce One 2006. Now offering bid for Hubwoo as of June 2015	www.perfect.com
Periscope Holdings	Headquarters in US. Privately held. Operating in the customer niche composed primarily of American states, cities and local agencies. Acquisition of BidSync, an established American cloud strategic sourcing suite vendor, in December 2014	www.periscopeholdings.com
Pool4Tool	Headquarters in Austria. Founded 2000. Privately held Company,	www.pool4tool.com
SciQuest	Headquarters in US. Founded 1995. eCommerce business-to-business exchange for scientific products. Conducted an initial public offering in 1999 (ISIN US80908T1016)	www.sciquest.com
SupplyOn	Headquarters in Germany. Founded in 2000. Shareholders Bosch, Continental, Schaeffler and ZF, thus an automotive central German network partnering with technology provider Seeburger	www.supplyon.com
Tradeshift	Headquarters in California, US. Founded 2009 in Copenhagen, Denmark, privately owned.	www.tradeshift.com
Tungsten (formerly OB10)	Headquarters in London, UK. Founded 2000. Renamed OB10 in 2005. Owned by 3 VC firms (FF&P lead VC) with operating loss	www.tungsten-network.com

Curriculum Vitae

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06/2015 – 10/2021	Doctoral Studies in Business Administration University of Mannheim, Mannheim, Germany
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