

THE IMPACT OF DIGITAL TECHNOLOGY IN INTERORGANIZATIONAL SUPPLY NETWORKS

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Introduction

The pace of technological development is increasing. Previously shifts in technological paradigms were separated by centuries, now they occur within a single lifetime and the adoption of new technologies over the past century (EEA 2015). These large-scale changes can also be referred to as *megatrends* to describe significant technological movements in global economy (Naisbitt 1982). In fact, megatrends can provide clues and signals of the near future and aid in assessing the future business environment (Guemes-Castorena 2009). Although recent attention has focused on discussing the digital revolution, academic contributions on the impacts of digital revolution remain scarce (Glas & Kleemann 2016).

Although megatrends have potential to provide possible clues of the likely future, some scholars argue that megatrends can be perceived as *empty signifiers*. It is suggested that that megatrends do not transport clear information of the phenomena itself; instead they act as a bracket for social changes (von Goeddeck et al. 2013). Moreover, their impacts should be individually assessed rather than taken as an inevitable future (von Goeddeck et al. 2013), which may lead to over interpretation of the phenomenon. In particular, working with such large-scale changes in an interorganizational supply network context can complicate understanding these changes as every company should assess the impacts themselves and in case assessments differ, it can inflict misunderstandings in the supply network.

Companies respond to these technology-related changes differently. Uncertainty created by these changes is perceived differently and in some cases, perception of a change does not correlate with measurable probabilities of a potential risk (Botterill & Mazur 2004). *Risk perception* can have an impact on how risks are perceived based on the memories, personal experiences and cultural context of an individual (Garvin 2001). Thus, based on the perception of an individual, impacts of technological change can be perceived differently: a threat, an opportunity or both. In fact, risks tend to have speculative characteristics and how an individual perceives this uncertainty, can enable the individual to see a risk provoking loss, downside risk, or risk provoking a possible profit, upside risk (Verbano et al. 2013).

An essential impact of technology-driven change is *uncertainty*. Although, it is possible to list potential impacts of technology-driven change, it is uncertain which impacts materialize (Waters 2007). Still, companies may need to require adapt to these unpredictable changes (Mittelstaedt 2014; Retief et al. 2016), although it is not certain which impacts technology driven change has. In fact, risks occur due to uncertain future and due to uncertainty, unexpected risks may occur (Waters 2007).

Academic literature on digital technology impacts is scarce (Glas & Kleemann 2016), although the pace of technological development is accelerating. It is crucial for a company to understand what impacts technological megatrends can have and therefore, this study aims to instigate scientific discussion on technology-driven change impacts and their perception on an organizational level. More precisely, we illustrate how these impacts create uncertainty, affect in supply networks and how they have affected on the value creation roles of network actors.

Theoretical background

Increased pace of technology driven change is complicating the business environment of companies and supply chains. These changes cause uncertainty for companies, which could present both threats and opportunities. A common view among scholars is that the pace of technological change is increasing, however there is a lack of consensus which technological innovations will be most revolutionary to companies. Technological megatrends could provide clues of potential threats and opportunities for companies.

Technology driven change

Academic literature on megatrends and their impacts for companies is at its infancy (Retief et al. 2016; Glas & Kleemann 2016). However, in recent years large and growing body of practitioner literature has investigated different megatrends. Although lacking peer-reviews, they can offer insights on what megatrends are considered significant by global consulting and accounting and management companies. In particular, digital technologies are suggested to be the fundamental driving force of the next technological revolution affecting individually and in fusion with each other (Guoping et al. 2017). Therefore, the search for digital technology megatrends focused mainly on internet search engines instead of academic data bases. In order to find consensus among different megatrends, a matrix was created based on the identified technological megatrends of following practitioners: EY (2017), PwC (2016), OECD (2016), Sitra (2017) and European Environment Agency (2015). Variety of different technological megatrends were expressed with little consensus. However, a common view among these practitioners was that the development of technologies is rapid and this megatrend seems to act as an umbrella concept for several different technologies. Therefore, technologies mentioned by these authorities were examined in detail to establish an understanding, which are the most applicable and prominent digital technologies to inflict technology-driven change.

Identified digital technologies include 1) big data & analytics, 2) industrial internet, 3) digital platforms and 4) augmented reality. Big data and analytics are used to analyse, predict and control business processes based on high-volume, high-velocity, high variety and complex data and is suggested to become an essential requirement for business (Coleman et al. 2016; PwC 2016). Industrial internet was originally coined by General Electric (2012) to describe connected machines, advanced analytics and people by communications technologies to monitor, collect, analyse and deliver insights to decision-making process (General Electric 2018). Digital platforms are suggested to offer new ways to consume goods and services by decreasing the transaction and friction costs (Guoping et al. 2017). Rapid development of digital technologies have enabled to experience new perspectives of reality through augmented reality (AR) having significant deployment possibilities for both consumers and enterprises (European Commission 2017).

Perception of uncertainty

It is suggested that *risk perception* mandates how uncertainty caused by these digital technologies are perceived. More precisely, it is suggested that the socially constructed perception is closely related to individual's cognitive framework developed by individual's experiences to mandate how reality is perceived and how individuals act in their environment (Abelson 1981; Fiske & Taylor 2008). Furthermore, these cognitive frameworks are stored in the memory of individuals and aid in anticipating other's behaviour, coping with the environment and represent reality (Fiske & Taylor 2008). Thus, identifying local implications can be based on subjective evaluations of an individual contributing to subjective risk perception (Herbane 2010).

On a company level, top management is usually in charge of creating cognitive frameworks and organizational outcomes can represent the top management's perceptions of the environment (Hambrick et al. 1984). Consequently, risk perception of individuals can contribute to organizational outcomes depending how technology related change impacts are perceived once they are identified. Altogether, these actions form a decision tree on how local implications are identified and perceived, which is visualized in Figure 1.

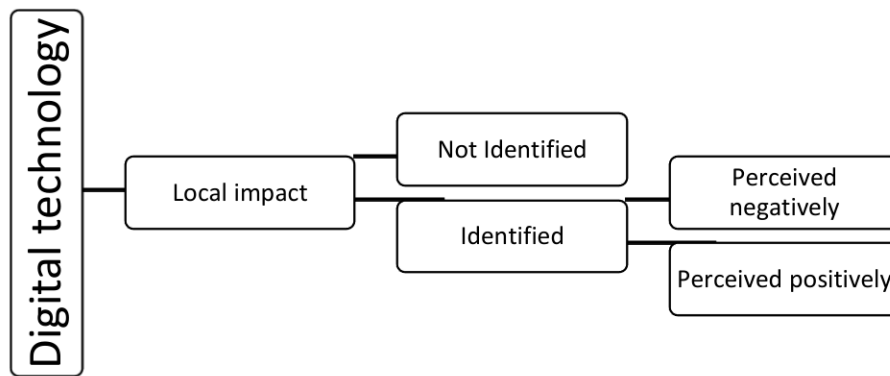


Figure 4: Digital technology perception decision tree

Digital technologies cause uncertainty and existing literature suggests that there are different dimensions of uncertainty varying from complete certainty to radical uncertainty depending on the amount of knowledge an individual has of a certain phenomenon (Vilko et al. 2014). It is suggested that it is certain that digital technologies change business, however its actual impacts are not known (Glas & Kleeman 2016), thus there is some knowledge of the future. Literature suggests that there are three different types of uncertainty when there is some knowledge of the future: 1) Parametric uncertainty, 2) structural uncertainty and 3) procedural uncertainty. In parametric uncertainty the structure of the future is known, however there is uncertainty of the parameters (Vilko et al. 2014), as in this case it is known that digital technologies will impact the future, however the parameters to which extent the digital technologies will affect are unknown. When the knowledge of the future decreases and no objective beliefs of the future can be stated, the uncertainty is referred to as structural uncertainty (Langlois 1984). Thus, it is uncertain how the future is and only subjective projections can be made what impacts digital technologies have. Procedural uncertainty describes the lack of skills and competence of computational and cognitive capabilities of an individual, which constrain understanding of potential risky events as a whole (Dosi & Egidi 1991; Vilko et al. 2014).

Methodology

Qualitative and explorative research design is applied to establish an understanding of technological change perception, technological innovation implications and its impacts to interorganizational supply chains. Case study approach was considered suitable for the explanatory nature of the study and provided an efficient means to examine a contemporary phenomenon in depth in its operational context (Yin 2009).

Empirical data was collected by semi-constructed interviews and stakeholder analyses. Interviews were mainly conducted with entrepreneurs and few managerial level. Informants as they were seen as experts in their industry and being able to provide insights. The process to identify stakeholders begun by employing value mapping tool prepared by the procedure of Bocken et al. (2013) which offered a means to establish an understanding of stakeholders and their relation to the firm. Next, the same stakeholders were categorized with a stakeholder analysis tool, which was prepared according to the procedure by Eden and Ackermann (1998). With this tool the identified stakeholders were assorted on a two-by-two matrix based on the commitment and influence of the stakeholders. Together these tools contributed to gain an overall understanding of stakeholder networks and their role to the case companies.

Case selection was based on information-oriented selection to maximize the empirical data (Flyvberg 2011). The cases offer insights to a variety of SMEs operation in different industries. Detailed respondent information and length of interviews is listed in Table 1.

Company	Company size	Industry	Sales 2016 (€)	Position of informant	Interview length (min)
Company A	Micro (1)	Wellbeing services, dietary supplement retailing	30 000	Entrepreneur	95
Company B	Micro (2)	Entertainment and activity services	-	CEO	70
Company C	Micro (5)	Restaurant and catering services	650 000	Entrepreneur	76
Company D	Micro (7)	Machining and metal product design and development	720 000	Entrepreneur	47
Company E	Micro (9)	Bakery and cafeteria services	850 000	Entrepreneur	54
Company F	Small (10)	Bakery and cafeteria services	700 000	Entrepreneur	45
Company G	Small (40)	Sports equipment and small machine retailing	14 000 000	Business controller Marketing manager	82 113
Company H	Small (47)	Transport and logistics services, wood chipping processing	4 800 000	Director of development	73
Company I	Medium (50)	Sports entertainment business	5 200 000	CEO	34
Company J	Medium (65)	Vehicle sales and maintenance	45 000 000	Marketing manager	142

Table 1: Respondent information

The interviews were personal face-to-face interviews conducted in Finland during fall 2017 and spring 2018 consisting of two or three interview rounds. During each round the studied themes were explored in more detail giving an opportunity for the respondents to become familiar with the terminology of the studied themes and to provide well-thought answers as well as to supplement their previous answers. The empirical data of the last interview is utilized in this study. The average length of the interviews was 75 minutes varying between 34 minutes to 2 hours and 20 minutes. During the interviews participants were asked to evaluate the impacts of certain megatrends.

Content analysis process was prepared according to the procedure by Tuomi & Sarajärvi (2018) which begun by listening and transcribing the interviews. Next, the transcribed data was uploaded to qualitative data analysis software Nvivo to enable coding the data into relevant nodes from which some partially arose from the data and some from the theoretical background. Then the nodes were categorized into 2nd order themes and further into aggregate dimensions according to the data structure suggested by Gioia et al. (2012).

Analyses and results

Perception of digital technologies and their impacts varied significantly among informants. The perception reflected a variety of positive, negative and both approaches to digital technologies and their impacts. The identified local impacts and their perception is visualized in Figure 2. In most cases, the entrepreneurs were in charge or identifying and perceiving these changes, however in some small and medium companies also top management and some employees took part in the process. Once local impacts of a digital technology were identified, the impacts were mainly perceived based on the previous experiences of the individual aiding to assess the nature of the impact. Furthermore, also supply networks provided information and clues on what impacts these digital technologies might have.

Augmented reality and industrial internet were perceived as rather unknown technologies for informants and received scarcity of identified impacts, which were mainly projections of how these technologies might affect in the future. More precisely, this technology seemed distant for the informants and how it might affect in the organizational context and as perceiving implications for their own company was challenging, identifying the impacts for the supply networks was even challenging.

Differences in perception and identification of megatrends begin on the definition of the megatrend itself, which was an unanticipated finding. In some cases, the informant was not familiar with the megatrend or considered the megatrend to have a different definition. One example of this is perceiving the digital technology of *big data and analytics*. Big data was understood as data collected from web sites and social media sites from customer behaviour, which was further utilized for marketing, planning and business activities. Furthermore, in some cases big data was perceived as evidence of customer preferences. Together, these findings indicate that big data and analytics offer a tool for companies to evaluate customer behaviour and it was perceived as an opportunity for companies.

Digital platforms received a variety of identified impacts. Digital platforms were used for purchasing and for reporting to their suppliers. Usage of digital platforms had increased expenses and workload for companies as well as decreased product selections and sales. More precisely, usage of digital platforms had brought expenses of purchasing software and equipment to use digital platforms. Furthermore, usage of digital platforms had increased the workload as the usage was challenging for employees, top management supervised the reporting and same information was needed to report on several supplier platforms due to compatibility issues. Digital platforms had also an impact on purchasing by transforming purchasing into e-procurement and decreasing the available product selection and products could not be seen before purchase. Furthermore, one informant noted that due to the growing amount of other digital platforms for second hand clothes and products, their sales had decreased. Altogether, the aforementioned implications of digital platforms were perceived as negative and complicating business. In contrast, the same informants who recognized negative impacts, were also able to recognize positive impacts of digital platforms. Usage of digital platforms brought transparency and ease to business activities. More precisely, digital platforms created automatically information that was seen useful and time-saving. Furthermore, digital platforms offer useful features such as tracking system and worktime monitoring.

Altogether, the findings seem to indicate of two different types of uncertainties: 1) Procedural uncertainty and 2) structural uncertainty. Concerning augmented reality, industrial internet and big data and analytics, it was challenging for the informants to describe the possible implications of these technologies due to their limited knowledge of the technologies. Consequently, limiting the understanding of potential future events caused by them and thus, indicating of procedural uncertainty. In contrast, local impacts of digital platforms received a variety of responses indicating that there is more knowledge of the future related to this technology. However, identified impacts were recognized in own business activities and presented as subjective statements, indicating of structural uncertainty.

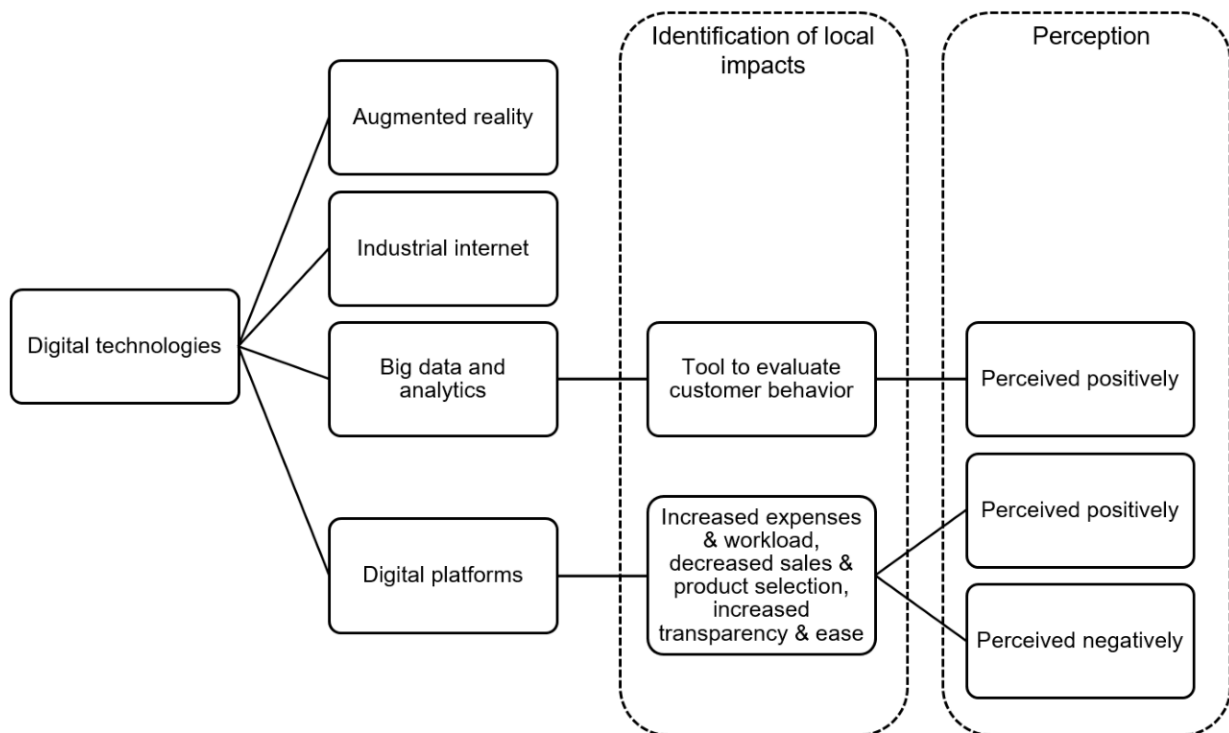


Figure 2: Digital technology perception

Conclusions

There is significant uncertainty related to digital technologies and their possible impacts. More precisely, uncertainty created by digital technologies can present opportunities as well as threats to companies and altogether, the findings seem to indicate that digital technologies are perceived as unpredictable and rapidly evolving technologies. Digital platforms received variety of different implications, which can indicate that currently this digital technology is identified as most influential among informants. Furthermore, the findings seem to indicate that the more identified local implications an individual identifies, the larger the perspective of perception is and both negative and positive impacts can be identified.

Besides having an impact on the activities of a firm, digital technologies seem to have more far reaching impacts and affecting in the supply network as well. Information of perception and impacts of digital technologies were exchanged within the supply networks, which can indicate that actors might become aware of how their suppliers perceive certain changes and decreased the amount of misunderstandings regarding the impacts of these technologies. Furthermore, digital technologies have transformed communication and business activities within the supply network. In particular, digital platforms have transferred certain tasks from one actor to another such as by enabling e-procurement, which alters the actor's role in the procurement process in a more independent way and the actor purchases through a digital platform. Furthermore, emergence of digital platforms have reduced sales by offering a new way to purchase products for consumers contributing to make an actor redundant in the supply chain as customers buy directly through the platform instead of making their purchasing at the actor.

This study makes several noteworthy *scientific implications* enhancing our knowledge of digital technologies' impacts to companies and supply network joining the discussion by Glas & Kleeman (2016). Furthermore, this study sheds light on the procedural and structural uncertainty caused by different digital technologies visualizing that the more distant a technology is for a company, the more uncertainty it causes. This was the case of augmented reality, industrial internet and big data and analytics and as the knowledge of these technologies was imperfect, their individual impacts could not be assessed. Consequently, without individual assessment, their impacts were unclear corroborating the idea of empty signifiers by von Goeddeck et al. (2013). Furthermore, identification of local implications was based on subjective evaluations and experiences of an individual, which further

supports the idea of Herbane (2010) of personalized risk perception. More precisely, in case the experiences of the individual were negative, the impact was perceived negative and vice versa, indicating that the experiences of the individual dominated how the change was perceived.

These findings also offer *managerial implications* by visualizing how uncertainty is constructed. By understanding different types of uncertainties, it is possible to mitigate uncertainty related to digital technologies. More precisely, searching knowledge of different sources of digital technologies and their potential impacts, can help establish an objective understanding of the impacts and contributing to establish a perception of these impacts that is not solely based on subjective evaluations of an individual.

The generalizability of the findings is limited in terms of research approach, small number of cases and geographical area.

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