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Succeeding Implementation

The Internet of Things as a Digitally Transformative Technology

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For Burrbaz.

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Abstract

The emergence of the Internet of Things (IoT) has generated technological shifts that have rapidly swept through myriads of organizations and businesses. The IoT refers to 'smart', sensor- and intelligence-imbued, interconnected systems, intended to generate and process context-aware data that can be used to improve organizational processes. Improvement of logistical-, process-, or management-efficacy allows firms and organizations to radically change and enhance the efficiency and scale of key aspects of their operations. Such change inevitably affects the actors, actor-groups, and stakeholders involved, regardless of their roles within the system. Digital Transformation describes the ongoing process in which organizations seek to create additional value through the implementation of digital technologies. This dissertation shows how the IoT can come to affect organizations, by describing and analyzing these changes through the use of three theoretical frameworks – the Technological Frames framework (TFR) developed by Orlikowski and Gash (1994), the Organizational Culture framework by Schein (1988; 2010) and the Practice Lens perspective by Orlikowski (2000). Three appended research papers detail effects of IoT implementation on actors and stakeholders documented in two separate case studies, and a fourth appended research paper describes a scoping study, examining the current discourse of IoT within the social science research-field, with all four papers being first-authored.

The results of the case studies and their three respective papers describe how organizational practices can come to change following the introduction of an IoT system and these changes' effects on the actors involved. This is detailed through descriptions and analyses of qualitative data obtained from interviews with representatives of all involved actors, and stakeholders, regarding their thoughts, perceptions, and actions related to the IoT system and its impact. Three areas in which an IoT system may cause rapid noticeable change are addressed: 'Actors', 'Organization' and 'Value Creation'. How each of these aspects are affected and their consequent effects on one another are described, based on the data obtained in the case studies and findings presented in the first three appended research papers. In contrast, the scoping study illuminates contextual elements of the IoT discussed by social science researchers, highlighting areas that have received too little attention but are crucial for successful Digital Transformation. In sum, this dissertation contributes to IS research by presenting and discussing results of two case studies involving IoT system implementation in two organizational settings with very similar work practices. It further contributes by examining one of these implementations in a longitudinal fashion, spanning two years, examining the changes both among different actors and within the organization itself. Lastly it contributes by identifying a major research gap in extant studies in social science-related aspects of the IoT, and addressing it based on the gathered results.

Preface

This dissertation summarizes and discusses results obtained in the following appended papers, which I first-authored and are referred to hereafter by the corresponding numbers:

Paper 1: Mähler, V., & Westergren, U. H. (2018). Working with IoT – A Case Study Detailing Workplace Digitalization Through IoT System Adoption. Proceedings of the IFIP International Internet of Things Conference (pp. 178-193). Springer, Cham.

Paper 2: Mähler, V., & Westergren, U. H. (2019). Facilitating Organizational Adoption of Sensor-Based Systems: Espoused Beliefs, Shared Assumptions and Perceived Values. Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS-52) (pp. 6470-6479). HICSS.

Paper 3: Mähler, V., Westergren, U.H., & Jadaan, T.S. (2022). Digital Transformation in Practice: Organizational Implementation of the Internet of Things, Under review in an international journal.

Paper 4: Mähler, V. (2019). The Thing About the Internet of Things: Scoping the Social Science Discourse in IoT Research. Proceedings of the IFIP International Internet of Things Conference (pp. 235-251). Springer, Cham.

Introduction

Understanding technology and its role as an agent of change has always been the core concern of informatics literature, both publications half a century ago and studies that appeared this year. The researchers studying information systems (IS) have multiple backgrounds, with the commonality of striving to examine and explain the effects of technology being implemented, from individual, through organizational, sectoral, and national to global levels. How we come to generate, share, process and understand data and information are processes that are both vast in scope, and difficult to pin down due to the rapid advances and constant technological evolution. For example, there are myriads of areas where new technology has dramatically changed the way we view, relate to, and execute processes. Technological devices such as smartphones, aided by rapid increases in connectivity and network-speed, have completely changed the way in which we consume media (Flintham et al., 2018).

Similarly, music streaming services have changed the way we 'consume' music and transformed processes of the recording and music distribution sector (Dewan & Ramaprasad, 2014). Computers have enabled massive increases in productivity, efficiency, and outputs of information workers across the globe (Tilson et al. 2010), and due to constant upgrades to network infrastructure workers no longer have to be tethered to the same country, or even the same continent, as their employers. Increases in the speed at which we can process data also continue to push the boundaries of what was considered possible mere decades ago. For instance, if you owned a top-end consumer graphics card from 2021 back in the year 2001, your graphics card would have *five times* greater computing power than the fastest supercomputer in the world at that time, based on number of FLOPS (floating operations per second), (Nvidia, 2021; ASC, 2013).

As technology is constantly changing it requires us as users, and our societies to change perceptions of the data we generate about ourselves. This applies not just to the data that we create ourselves, but also to data we generate externally through applications or webpages. The changes – ranging from the apparently innocuous (such as app-permissions) to profoundly intrusive (such as the use of facial recognition algorithms) – and needs to regulate them are prompting formulation of new legislation in parallel to the new ways of benefitting from the data they generate (Regulation E.U, 2016). As we are moving into an age in which data is becoming a new form of commodity, technology is following suit with many new and innovative ways of generating additional value based on generated data, vast wireless telecommunications networks, and ever-increasing numbers of users of mobile phone and other devices that enable almost instantaneous mass communication.

A prominent example of such a technological shift is the emergence of the 'Internet of Things' (IoT hereafter), referring to the interconnection of everyday objects that have been imbued with intelligence and given the ability to generate context-aware data. An IoT-system is a system of sensors that can receive, transmit, generate, and analyze data free from manual human input. These systems have the ability to generate context aware data, relating to and/or based on external factors, with examples such as: date, time, temperature, events performed, or conditions met. An IoT-system may also contain some manner of storage for the generated data, with or without the added ability and processing power to analyze said data.

The analysis can vary based on the needs of the data owner, but with some examples being: trendspotting, processes optimization, future predictions based on current data, and resource management (Baiyere et al., 2020). This opens up many previously unexplored avenues for organizations that seek to implement IoT-systems in terms of how and what value is being generated for customers, vendors, and manufacturers alike. While the concept of *ubiquitous computing* has been studied by IS-researchers (*eg*. Weiser, 1993; Greenfield, 2010), IoT turns what was initially thought of as a concept into reality, made possible through decreasing cost of sensors and increasing processing and data generating capability of commercial present-day technology (Borgia, 2014). Examining how implementations of new systems affect processes and organizational actors is by no means a new idea in IS research. However, the research on IoT systems differs in that these systems lack clear boundaries of when an actor is engaged with or influencing the system. When compared to 'traditional' IS-systems that might be limited to functioning within a computer or computer-network, an actor involved in an IoT-system may themselves be serving as a data point, without their own knowledge or understanding (Jonsson, 2016).

As an organization seeks new ways of generating value with the help of technology such as IoT systems it is also argued that the adaptions needed to realize the value leads to needs for major changes within organizations or teams to fully realize the technology's potential (Vial, 2019). This is one of the major aspects of research on 'Digital Transformation' (DT) – which focuses on ways in which stakeholders, business, and organizations facilitate digital innovation. A DT of an organization can be seen in terms of both the enactment and resulting outcomes of change to products, business models, or services. In addition to these factors, a DT is also described as affecting the socio-cultural, technological, and strategic aspects of an organization, manifested in terms of revenue-streams changing or realignment of what the organization considers to be creating additional value (ibid.). This can, for instance, take the form of an organization moving towards a system-as-a-service mindset from one-off-transactions – or changes in how technology or data generated by the technology are handled.

Relative to most other 'established' concepts within IS-research the Internet of Things and Digital Transformation can still be considered new areas of study. Because of the novelty of both IoT and DT there are still several areas where additional research stands to benefit both academia and practice. Much of the performed IS research regarding IoT deals with the way it can be implemented in terms of optimizing processes within different industries and organizations.

Research into Digital Transformation describes IoT as an enabling technology when trying to facilitate a digital transformation (Vial, 2019; Newell & Marabelli, 2015) – yet struggle to properly describe what the transformation may look like in practice. A lack is also described regarding digital transformation studies, especially in terms of case studies, longitudinal studies, and studies regarding the effects culture and values play in DT (Kutzner et al., 2018, pp. 6-8). This allows for several areas where this dissertation stands to contribute in terms of IS-research, where the goal is to not only explore the capabilities of IoT when used in practice, but additionally how and indeed if IoT systems may be considered as an enabling technology regarding digital transformation in practice. Provided that IoT has the capacity to work as an enabler for digital transformation, the effects are not just limited to the involved actors or actor groups – but effectively work as a way of transforming how the organization leverages the system and its data to generate additional value either within the organization, or as a profit for the organization.

To examine the potential of IoT as a technology, both in and of itself, as well as its espoused potential to function as an enabling technology for facilitating digitally transformation, this dissertation seeks to answer the following research question: *"How can IoT facilitate organizational digital transformation – and how can we further study and understand the effects of IoT capabilities on both the involved actors and organizational practices?"*

This question is addressed by looking at the effects of IoT on both workers, managers, and additional stakeholders – individually as well as within their own organizational groups. It is further examined how socio-cultural aspects may come to influence each of these categories, and how their present configuration might have come to affect the implementation. This is done through two case studies of effects of IoT implementation on maintenance work and associated actors, using three established theoretical frameworks, published in three appended papers that explored aspects of the IoT and its role as an enabler of DT. Further information considered was obtained in a scoping study of recent IS research on the IoT, based on extant publications in journals. The studies and findings are summarized in following chapters, together with discussion of the results, and their implications for future research on the IoT and its role in DT.

IoT – A digitally transformative technology

The following sections present theoretical foundations for the rest of the dissertation, and findings from previous research to provide background information for the studies (outlined above) that this thesis is based upon and their subsequent discussion. Initially in this chapter the history and concept of the IoT is explained in greater detail, with examples of IoT technology that have been enacted in practice. IoT's role as an enabler of digital transformation is then presented, along with a more detailed description of DT as a phenomenon.

Defining the Internet of Things

To address the Internet of Things and associated phenomena, a brief description of its origins is warranted to help efforts to understand what it was initially intended to achieve and how it has come to significantly expand since then. According to Borgia (2014), the early conceptualization of what would become the IoT originated in the Auto-ID Center at MIT, where researchers worked on the development of Radio-Frequency Identification (RFID) technology. This enabled items ('things') to be tagged and recognized in a similar manner to bar-coding of grocery items so they could be readily scanned and linked to an inventory. However, instead of using the visual laser scan of a printed barcode, the 'scan' would involve use of weak radio signals to transmit, collect, and/or store data. Along with RFID, the researchers also worked on the development of a universal identification system called the Electronic Product Code, intended to expand RFID, and allow its use in worldwide networks by giving each individual identifier a unique signature – the same core concept that is imbued in all IoT devices and objects today.

Since its inception, IoT has now grown to where it is no longer exclusively associated with RFID tags – instead the term *smart object* is used, describing everyday objects imbued with intelligence. This imbued intelligence ultimately enables the smart object to far exceed their normal functionality by allowing them to collect, transmit and store information from their surrounding environment, and through this control or interact with the physical world, while simultaneously being interconnected to one another. The 'smartness' can be conferred by anything from small sensors embedded in household objects to large-scale multinational networks of sensors such as those used to track vast amounts of transported goods, e.g., freights or cargoes hauled by trains (Jesse, 2018). To detail some instances of IoT-technology being used to achieve greater value for stakeholders, two examples will be given on the upcoming page, detailing different areas where IoT technology has been successfully utilized and changed the way that services are provided or understood.

An IoT system has two crucial elements. The first is a set of sensors that are used either separately or connected to objects to measure or confer additional usability on the objects. The second is some kind of system that enables collection, analysis and/or manipulation of the data generated by the sensors. This means that a sensor in itself is not an IoT system, and neither is a system with no sensor input. Because of the difference between IoT systems and more traditional systems (such as Enterprise Resource Planning or Customer Relationship Management systems) IoT systems have also been described as cyber-physical systems – on account of the connections between the physical and digital worlds in smart objects (Poovendran, 2010; Borgia, 2014).

T0 exemplify what an IoT-system may entail I draw upon extant research, presenting two IoT systems, one based on a real-life case study and one on a hypothetical case. In the first example, presented by Saarikko et al. (2017), a global company intended to create a connected, or smart, washing machine. A proof-of-concept smart washing machine was built, based on ideas generated by multiple actors during a workshop event. In connecting the washing machine and allowing for data to be generated, gathered, and transmitted from each individual machine, potential for added value was identified in the possibility for simplifying repair for technicians, using error codes or generated data from the machine. Additionally, the ability to locate specific washing machines more easily in large-scale settings (such as apartment buildings or laundromats) could shorten the time a technician required to find a malfunctioning machine. Another suggested benefit was that the generated data regarding use of washing machines could enhance the design of future products. I find this to be a succinct example, as it allows one to visualize other potential areas, such as predictive maintenance of other types of machines, based on motion or even sound sensors that can detect changes and record them to ease diagnosis of faults and the machines' repair, regardless of what they might be used for.

In the second, hypothetical – and somewhat hyperbolic – example, we are the owners of a couple of hundred self-serve soda coolers. These are the coolers that can be found at gas-station and the likes, resembling a fridge with a glass door, not a machine that dispenses soda, but one with shelves from which customers pick soda bottles. To simplify the logistics of refilling our coolers we install a small sensor in each of the machines along with a camera for each of the shelves. The sensor can measure the temperature both inside and outside the machine and provide a timestamp of when the reading was taken. Additionally, the small camera fitted in the roof of each shelf is designed to take a picture of the bottles as one is being taken – so we know the brand of soda that needs to be restocked. By combining the pictures with sensor readings in a central system we can also identify when and where people buy specific brands or flavors, and their relative popularity.

The modifications to our cooler have helped us logistically by providing knowledge of when, where and with what we need to restock. However, we realize that the rudimentary machine-learning algorithm we are using to identify which soda bottles are being taken could be upgraded and improved, possibly allowing us to generate greater value even if we are not entirely sure what that value entails. We let the algorithm work on our generated data and pictures as we are further building up our dataset, eventually spanning thousands, or tens of thousands of interactions.

We realize that while we cannot survey each and every customer using our products, we have an image of each customer's hand. Suddenly we have a dataset that a machine-learning algorithm could use to start to determine which brands are preferred by men or women based on the shape of the hands, by married or unmarried people based on whether or not the hands have a ring on the ring finger, and relative ages of the people (if they are not wearing gloves). Such data can now be extremely valuable for soda companies in terms of marketing, and either eliminating the need for consumer surveys or increasing their predictive value. While this hypothetical example might be rather far-fetched currently it is by no means beyond the realm of possibility with existing technology. It also illustrates how seemingly innocuous data can be analyzed by systems in ways that we would not necessarily expect and may be highly revealing about deeply personal matters.

However, the possibilities, both real and hypothetical, offered by IoT technology have resulted in a technological shift in terms of the additional functionalities that can be (and are) imbued in everyday objects. The IoT has rapidly become a massively important aspect of both societal and organizational environments. Illustrative estimates suggested that 35.82 billion devices would be connected globally in 2021, with a generated value upwards of 1.9 trillion dollars (Statista, 2021; Ericsson, 2016). The examples of sensors and their systems are intended to explain what a sensor-based system may be like in practice, but a theoretical distinction is still needed to clarify what I mean when I talk about the IoT in the rest of this dissertation. For this I use the following definition by Borgia (2014, p. 1) of an IoT system as one that: *"Combines aspects and technologies coming from different approaches. Ubiquitous computing, pervasive computing, Internet Protocol, sensing technologies, communication technologies, and embedded devices are merged together in order to form a system where the real and digital worlds meet and are continuously in symbiotic interaction*".

In applying this theoretical explanation, I make no delimitations in terms of differences or similarities between concepts such as ubiquitous computing, pervasive computing or similar terms that aim to explain this type of technology.

IoT systems, or cyber-physical systems as they were previously called, have been expected to play a major role in bridging of the physical, cyber, and social worlds (Schirner et al., 2013). Moreover, this expectation has been met, as readily observed in the rapidly growing numbers of connected smart objects and anticipation of further continuous growth. However, as the hypothetical example presented above showed, these types of systems may offer both additional value, and other features that can intrude on one's privacy, especially since IoT systems can be embedded in a multitude of settings – ranging from single personal devices to entire buildings, multi-national infrastructural systems, or global platforms (Park et al., 2012; Borgia, 2014). Thus, the IoT raises important issue that require consideration not only of its effects on business or value models, but also how social aspects are addressed to generate value (Porter & Heppelman, 2014).

The scoping study presented in Paper 4 showed that a majority of the extant social science research dealing with the concept of *privacy* and IoT did not deal with *personal privacy* for individuals within the IoT system. Rather the social science discourse regarding privacy was mainly dealing with the securing of protocols which were used by smart objects to communicate amongst themselves, as well as making sure that the data itself remained private (*e.g* Tawalbeh et al., 2020; Peppet, 2014; Trappe et al., 2015).

A study by Zheng et al. (2018) exemplified this and further revealed similar sentiments among the end-users of supposedly private forms of IoT technology in the so-called 'smart home' system category. This category encompasses IoT systems providing convenient control of numerous things (smart appliances) in domestic environments, such as opening blinds, changing colors of lights, and turning heating up or down remotely with the touch of a button on a smart phone. The cited study describes how the owners of such systems all expected their privacy to be protected when using their systems, regardless of the brand of the IoT system used.

However, ironically, none of the respondents actually verified that any of the protections were in place in their system – making the thought that it was private appealing, but not one that was actively confirmed. The respondents were also considered to have little awareness of the potential threat to their personal data, or that both algorithms and machine learning systems could draw revealing inferences from non-audio/visual data. The threat of machine-learning is similar to that of the hypothetical system previously presented – that one might be part of an IoT-system without realizing or being informed about it (ibid.). This would constitute a serious issue, not only for the users of the IoT system, but also if a mindset such as this exists in other aspects of IoT implementation, where the user thought that their privacy was being adhered to, but with no readily available way to actually confirm this on a larger scale, such as in an infrastructural setting.

IoT and its role in data generation and analysis

While a single smart object may not generate much data in and of itself – an IoT system consisting of thousands, or tens of thousands, of closely connected and interconnected smart objects will suddenly be able to generate enormous amounts of data very quickly. These types of massive datasets all fall under the umbrella term of Big Data. Although such 'Big Data' is not an exclusive feature of IoT systems, they will have the capacity to generate the massive quantities of data that meet Big Data criteria (Ohlhorst, 2012; Zaslavsky et al., 2013). The ability to generate vast amounts of data is a key aspect of IoT technology, so it is important to briefly describe and explain the relevance of Big Data in this regard. However, the following description is intended to familiarize the reader with the concept related to IoT rather than for the description to provide a comprehensive explanation of Big Data.

Big data refers to extremely large datasets that can reach the size of several *petabytes*. In order to conceptualize what exactly a *petabyte* of data entails, one example is to consider a regular pdf-document – containing around 200 pages of information. The file size to be about 10mb of data or 10^7 bytes of data, while one *petabyte* of data equals 10^{15} bytes of data - or two quadrillion (two million billion) pages of text within our hypothetical document. This massive amount of data still only accounts for a single dataset out of a multitude of different already existing ones (Ohlhorst, 2012). In describing what is commonly considered to be the most important aspects of big data, Ohlhorst (ibid.) lists the *volume, variety, veracity,* and *velocity* of the data.

The volume entails the size of the dataset – with the size ranging from terabytes (10^{12} bytes) to petabytes (10^{15} bytes). Variety describes the structure and variance of the data *i.e* 'what the dataset contains'. Veracity is used to describe how pure the data is in terms of statistical viability, how the data is structured and represented, and if there are any data discrepancies. Lastly the velocity of the data *i.e* 'speed' in terms of streaming data or accessing it from archival sources. In terms of IoTs role in big data, it has been argued that the data which is purposely generated by sensors is also laden with contextual information in terms of other aspects that the sensor might be reading. This can include data surrounding the measured properties, available number of sensors, their configurations, and locations – all available as contextual information (Zaslavsky et al., 2013, p. 4).

While the sensors that are present within an IoT-system are responsible for the data generation, they are not able or intended to provide any in-depth analysis of the generated data. This is instead done with the help of separate systems, that can either exist as part of the IoT-system, or as a separate one solely intended to analyze these extremely large datasets.

In terms of business applications 'Big Data' has been described as a major disruptive change in the context of a networked business environment (Baesens et al., 2014), and also changing the way that businesses operate. Günther et al. (2017, p. 191) further argues that "*Organizations need to continuously realign work practices, organizational models, and stakeholder interests in order to reap the benefits from big data*".

This is further described by the cited authors in the form of propositions regarding potential cross-level interactions. They describe needs such as requirements for the insights gained from Big Data to be paralleled by development of appropriate organizational models, and how the insights gained from Big Data at a work-practice level raise new stakeholder interests that limit the value realization that Big Data can offer (ibid.). Within an IoT-system data is constantly being generated, transferred, or analyzed in one form or another at all times. Either between sensors or the individual system that is linked to these sensors, collecting and/or analyzing the data. In order for the system to function as intended, and not to fill up the limited storage capacity of the sensors themselves, gathered data must eventually go somewhere to become stored, deleted, or overwritten. And because of the relatively low cost of storage, it makes greater sense for organizations to save their data rather than to simply delete it (Ohlhorst, 2012), meaning that enormous quantities of data are being generated and saved on a daily basis in large IoT-systems.

Because of the data generated in IoT systems the sensors that send, receive, and analyze data all become contributors and beneficiaries of Big Data analytics (Zaslavsky et al., 2013). A big dataset that is being used together with algorithms or machine learning systems can also enable higher levels of automation in operational as well as strategic decision-making (Loebbecke & Picot, 2015; Markus, 2015; Günther, 2017), which was previously regarded as too complex, and requiring human judgement (Chen et al., 2015; Gillon et al., 2014).

This speaks not only to the business capabilities afforded by Big Data itself, but by extension an IoT system that can generate large datasets that may benefit not only the host organization but also potential external actors in terms of services provided. Moreover, while Big Data is the subject of a research field in and of itself, it is tightly linked to the IoT, and another important aspect to consider, especially for practitioners since failure to capitalize on the data would prohibit realization of much of the potential added value.

This brief description of Big Data is intended to familiarize the reader with one of the key aspects of IoT technology and show how it opens new avenues for creating additional value for organizations, which are further examined in the following section.

Creating additional value with IoT

It has long been established that that information technology enables for greater productivity for organizations, either through the storing and manipulation of information (Kling, 1980), improving productivity (Myers, 1970), or the reduced cost of information exchange (Aral et al., 2012). Little has changed in terms of the truthfulness of these observations over the decades since their publishing, with computers and similar information technology now being a natural aspect of organizations. Similar to the early research of information technology, the early research into IoT-technology studied mainly the architectural, infrastructural, and technological perspectives of these, with few of the early studies examining the organizational aspects and impacts to a similar amount (Vermesan & Friess, 2013; Whitmore et al., 2015). This raises issues as organizations are left to test the technology on either themselves or their customers, with the potential for setting the standard with little or no input generated from the research community (Senn, 1998).

IoT research has shown that it may shape the ways that organizations co-operate and the potential partnerships that can form in development, production, or maintenance of an IoT system (Vial, 2019; Pflaum & Gölzer, 2018). As IoT systems consist of sensors that are either pre- or custom-built along with a mode of storing and analyzing the sensor data, only a select few of the very large tech organizations have the ability and infrastructure to build and design every element of a new IoT system from scratch. This increases the likelihood of IoT systems being developed instead by an eco-system of firms, where one may deliver the sensors, another the software, and others various services based on the captured data (Porter & Heppelman, 2014; Saarikko et al., 2016; Saarikko et al., 2017). Additions to the organizational eco-systems also emerge as the analysis of an organization's generated data can require vast quantities of computing power. These kinds of service providers may become necessary if an organization is too late to adapt and lacks the computing power required to gather and analyze large quantities of data (Zaslavsky et al., 2013). The formation of organizational eco-systems inevitably relies to some extent on all the organizations involved agreeing that the stakeholders within each of the organizations have overlapping ambitions and mutual goals (Saarikko et al., 2016).

Individual stakeholders may, of course, have diverging perspectives of the parts of an IoT system's development or operation that generates additional value for them. Thus, Porter & Heppelman (2014) argue that firms need to make strategic choices regarding their own data management as part of the shifts in business strategies engendered by digital technologies that affect the ways organizations operate. This is similar to the discourse regarding Big Data as well, seeing that the data itself can offer increased value to the organization as well.

Extant research shows that IoT technology offers the potential to generate additional value in a multitude of sectors. These sectors include, but are not limited to: industry, where it enables predictive maintenance and greater efficiency (Saarikko et al., 2017); medicine, where healthcare service providers can personalize patient care or use monitoring systems to assist patients (Lee & Lee, 2015); businesses, where it enables additional value propositions and revenue streams (Dijkman et al., 2015); manufacture, in terms of energy saving through machine monitoring (Kang et al., 2016); retail, where 'smart objects' enable new forms of sales and improvements in analytics that can be leveraged in terms of future sales (Grewal et al., 2017); transport, through formation of interconnections between commuters, city resources and public transportation systems (Chavhan et al., 2019); tourism, through the improvement of infrastructure and provision of easy travel information to users (Gretzel et al., 2015); infrastructure, though outfitting cities with sensors for maintenance and additional functionality (Hashem et al., 2016); and big data generation and analysis (Jin et al., 2015). This non-exhaustive list clearly shows that IoT technology is pervading increasingly numerous aspects of our daily lives.

In terms of business value that can be created, the IoT offers ways of generating additional revenue streams compared to 'traditional' singular transactions. This is because of the massive amounts of generated data, as described in the previous chapter, together with additional offerings that are inherent to the technology itself. In the example presented by Saarikko et al. (2017) described above, value was added for the organization in a way that differed from the singular generated value of selling a new and improved washing machine. Instead, the washing machine now gave the company additional and previously unavailable ways of improving their products in terms of future design, time and efficiency of repair work, and ease of locating their own products, with corresponding adaptations of their marketing or organizational strategies. Every sold washing machine subsequently presented both customers and the manufacturer additional value – translating into greater business value if expanded further. In economic terms this can be considered an adjustment of an organizations economical model – where the technology is enabling it to move from what could be considered a traditional transaction based one – towards an economic model that is instead a 'pay-as-a-service' one – in terms of data that can be gathered and allow for new value to be created (Pflaum & Gölzer, 2018). This ultimately leads to the changing of entire business models as they begin to further change their business logic in terms of how they operate as a firm (Osterwalder et al., 2005). Because of the way that IoT enables for the changing of an organizations way of operating it has also been regarded as a key transformative technology - meaning that it enables firms to create new business processes and value propositions, in comparison to what other technologies may offer (Atzori et al, 2010; Baiyere et al., 2020), also relating to its description as a technology that enables digital transformation (Vial, 2019).

Digital Transformation and IoT as an enabling technology

To understand how IoT can be a digitally transformative technology we must first establish what is meant by DT. According to Vial (2019, p. 118), DT is *"a process where digital technologies create disruptions triggering strategic responses from organizations that seek to alter their value creation paths while managing the structural changes and organizational barriers that affect the positive and negative outcomes of this process"*.

While the term *digital transformation* is not new, its etymology has gradually changed over time. It was first used interchangeably with concepts such as 'digitization' and 'digitalization' (Gong & Ribiere, 2021). Saarikko et al. (2020) clarify this, explaining that 'digitization' constitutes a technical process where analogue information is copied into its digital counterpart (Bloomberg 2018), while digitalization is a socio-technical process in which IT is used to further enhance business processes (Tilson et al. 2010). In contrast to these two concepts, *digital transformation* refers to a socio-cultural process that involves *both* technological and organizational factors, resulting in changes in the internal processes that ultimately lead to entirely new outcomes through generated change – and not just enhancements or re-branding of existing processes (Haffke et al 2017; Gong & Ribiere, 2021; Hartl & Hess, 2017).

DT is a process through which organizations can create new forms of both internal and external collaboration, which is becoming extremely important for businesses (Kutzner et al., 2018). It is also a process that affects the cultural values within organizations (Hartl & Hess, 2017), and leads to the generation of new (as well as specialized) competencies among information workers (Alexander & Lyytinen, 2017). In contrast to the generally specific (and *relatively* static) IT systems addressed in 'traditional' IS research, DT is considered to be an ongoing process within organizations that demands adaptation of organizational strategies in response to changes in external factors (Piccinini et al., 2015).

Digital technologies as described by Bharadwaj et al. (2013, p.471) regards the *"combinations of information, computing, communication, and connectivity technologies"*. This definition has been further expanded by Vial (2019) recognizing technology as an enabler of digital transformation, while also adding *Platforms* and the technology encompassed in the SMACIT acronym, describing: *Social*, *Mobile*, *Analytics*, *Cloud*, and *Internet of Things*-types of technology (Sebastian et al., 2017). This is also what is referred to when digital technologies are mentioned in this dissertation. While IoT remains the focal point, it stands to reason that due to the shared similarities of the SMACIT-technologies, there may exist similarities in the effects they generate in terms of organizational change.

Extant research has shown that use of IT and digital technologies (re-)shape business operations (Venkatraman, 1994) and organizational business models (Chesbrough, 2010; Rai & Tang, 2014), by facilitating new forms of collaboration such as company sponsored value co-creation (Chen, Marsden & Zhang, 2012), value networks (Westergren & Holmström, 2012), and formation of platform ecosystems (Tiwana, 2013; Skog, 2020). IT and digital technologies can further inspire service innovation efforts (Vargo, Maglio & Akaka, 2008), and enable new ways of organizational strategizing (Besson & Rowe 2012).

DT differs from IT-enabled organizational change in terms of the effects it can have outside of the sphere of the organization undergoing the transformation (Vial, 2019), and digital technology is fundamentally changing its value proposition and identity rather than merely supporting and enhancing them. Several studies have highlighted the link between implementing digital technologies and DT (Appio et al. 2021; Nadkarni & Prügl, 2021), and shown that IoT systems can potentially function as digitally transformative technology (Gray et al., 2013; Günther et al., 2017; Newell & Marabelli, 2015; Westerman and Bonnet, 2015; Vial, 2019).

Because of the role digital technologies like IoT can play in changing value creation (Chesbrough, 2010; Rai & Tang 2014) along with the changing of how value is created among organizations through digital transformation (Atzori et al, 2010; Baiyere et al., 2020) digital transformation is argued to inevitably lead to the changing of an organization's business model (Vial, 2019). A business model is described as; *"a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams."* (Osterwalder et al., 2005, p. 10).

In their performed taxonomy on Digital Transformation literature Kutzner et al., (2018, pp. 6-8) remark on the fact that only a few of the identified DT studies within their paper were longitudinal in nature. An additional observable lack of research was also seen in regard to studying the end-users as a part of the Digital Transformation, along with studies in terms of how the culture and values were affected through DT. Since the Digital Transformation can be considered a socio-cultural process – how end-users and organizational culture is affected becomes an important aspect that is missing from DT research (Haffke, et al., 2016). It can be argued that in failing to study socio-cultural aspects of DT, one is also missing an important piece of the puzzle, and in doing so also making any claims about the capability of Digital Transformation significantly harder to put into context.

The three theoretical lenses

Although researchers have addressed aspects of IT within organizations since the 1950s, the discipline of Information Systems (IS) research began to take form with theoretical foundations outlined by Börje Langefors (1966) in a book entitled 'Theoretical Analysis of Information Systems'. It has since grown to include multiple streams, and although present-day technology is a far cry from the technology that existed in 1966, the core of the research remains the same, with early studies describing organizational changes triggered by IT (e.g Markus & Robey, 1988; Robey & Boudreau, 1999).

Present day IS-research now covers a large range of technical, organizational, and sociological aspects of technology – utilizing a multitude of tools, models, and frameworks to examine diverse aspects of effects of technology. Moreover, while it is argued here that diverse tools are necessary, the breadth of tools, models, and frameworks – along with a lack of a universal model or theory of IS research – has remained a point of discussion among many IS researchers (e.g Keen, 1980; Galliers, 1992; Falkenberg et al., 1995; Benbasat & Zmud, 2003; Sidorova et al., 2008; Avison & Malaurent, 2015).

In addition, while some IS researchers have called for a more cohesive description of what IS research actually entails (e.g., Walsham, 1993; Mingers & Stowell, 1997), it is argued here that a broad way of examining technology will become increasingly important, as digital technology such as IoT comes to broadly affect our lives, and in some cases even without our awareness.

Because of this I have used three distinct theoretical lenses to examine and analyze two separate case studies where the IoT altered the way that work is performed – and the organizational ramifications of such change. In order to facilitate understanding of the case studies and findings, this chapter is intended to familiarize the reader with the three theoretical lenses, and how they may be connected to other aspects of organizational changes, users' perceptions of the roles of IoT systems, its effects on their own role, the concept of DT, and how IoT can function as an enabling technology for businesses to digitally transform.

These theoretical lenses all facilitate study and understanding of different aspects of technology within organizations. Thus, their combined use allows a richer view of IoT in the context of DT, and deeper elucidation of the complexities of IoT-related phenomena. The three lenses that will be presented within this chapter are the Technological Frames framework (TFR) by Orlikowski and Gash (1994), the Organizational Culture framework Schein (1988; 2010) and the Practice Lens perspective by Orlikowski (2010).

Technological Frames – Understanding the system

Consideration of social aspects of technology has generated multiple prominent theories. Some of the earliest research on social aspects of technological change (focused on attitudes, beliefs, and social dynamics of technology) dates back to the early 1990s (Fulk et al., 1990; Aydin et al., 1991). In subsequent extensions, researchers like Orlikowski (1992; 2000) and Poole & DeSanctis (1992; 2004), addressed how decisions surrounding the use of technology are affected by institutional and organizational norms, and how uses of technologies shape *future* technological uses (Leonardi et al., 2012). Studies by Barley (1990), Edmondson et al. (2001), and Boudreau & Robey (2005) further showcased how socially negotiated changes in use of technology over a period of time can shift dynamics of teams, organizations, and entire occupations.

Ascribing to the notion of Karimi & Walter (2015) that digital technology is inherently disruptive, it presents a different kind of challenge for research, where many succinct and useful frameworks exist, but few are tailored to incorporate either digital transformation or the ubiquitous nature of digital technologies such as IoT. This presents opportunities to examine extant frameworks and see how the knowledge that has already been generated can come to be built upon and used to view new technology through an already established theoretical lens.

When studying IoT-technology and how it enables for digital transformation – the inclusion of socio-cultural aspects (Haffke, 2017), strategies and the effects of implementing digital technology (Vial, 2019; Gray et al., 2013; Bharadwaj et al., 2013) I have found the *Technological Frames* framework (TFR) by Orlikowski & Gash (1994) to serve as a useful tool in understanding how technology can come to be perceived differently among stakeholders.

Orlikowski & Gash (1994, pp. 13-14) describe three domains that they regarded as highly important within their empirical setting:

- *'Nature of Technology'*, which refers to people's images of the technology and their understanding of its capabilities and functionality.
- *'Technology Strategy'*, which concerns people's views of why their organization acquired and chose to implement a focal technology. This includes their understanding of the motivation or vision behind the adoption decision, and its likely value to the organization.
- *'Technology-in-Use'*, which refers to people's understandings of how the technology can be used on a day-to-day basis, and the likely or actual conditions and consequences associated with such use.

The two concepts of frame '*congruence*' and frame '*incongruence*' are considered important factors when examining the potential in terms of a successful or unsuccessful implementation of an IT-system. In terms of congruence, it pertains to the actors having similar expectations of what the role of the technology is regarding business processes, the nature of the technological use, or what frequency or type of support and maintenance that is required. Contrasting to this, incongruence regarding the Technological Frames would then imply that there are important differences in terms of either the knowledge, expectations, or assumptions regarding central aspects of the technology (Orlikowski & Gash, 1994, p.8). The Technological Frames framework has been described as a seminal study in terms of creating a conceptual framework for both Technological Frames of reference as well as a systematic approach to socio-cognitive research regarding IT (Davidson & Pai, 2004). While there are multiple reasons that this thesis draws upon the generated knowledge in TFR two aspects stand out as particularly important when trying to understand the role of IoT as a digitally transformative technology when using the Technological Frames framework.

The first aspect is that TFR requires researchers to define and categorize a rather ubiquitous concept when examining technology such as IoT. This is important as prominent early IS research highlights the necessity of examining features related to a new technology, and also how these features act to either enable or constrain affected actors (Poole & DeSanctis, 1990; Monteiro & Hanseth, 1996; Griffith, 1999). Despite the extant literature describing this importance, the information systems research community still struggles with the vagueness of how digital technology is conceptualized in terms of being an enabling technology for digital transformation (Vial, 2019). To mitigate this, the Technological Frames framework demands that we characterize the technology in such a way that it maps against the three domains when interviewing affected actors. This makes it harder for a researcher to black-box the technology – a phenomenon in which the technology is either overly simplified or regarded as a stable or inert artifact and thus not explained (Orlikowski & Iacono, 2001).

Secondly TFR provides a succinct framework from the onset, yet due to its comparative simplicity to other frameworks it remains modular in terms of how additional theorization may be added, particularly in terms of viewing the various aspects of 'congruence'. These aspects are however often examined in terms of the user's perception surrounding the technology, with less focus placed on congruence of extant organizational structures. Researchers have thus called for additional longitudinal studies in order to identify and observe the incongruence develop over a period of time (Davidson & Pai, 2004). While TFR serves as a good way of examining the understanding of an IoT-system within an organization - to understand the socio-cultural aspects of change that comes with DT – there is also a need to study how organizational culture and structures are affected by IoT.

Organizational Culture framework – Facilitating the system

Organizational culture theory was initially developed by Schein (1988) and has been applied to address diverse phenomena in various settings, including cultural aspects of knowledge management (Alavi et al., 2005) and IT adoption (Cooper, 1994). It provides a way of studying culture and values regarding IS (Leidner, 2006), clarifying cultural, structural and hierarchical features of an organization, and elucidating how they can both affect and be affected by technology usage (Schein, 2010). The framework, as described by Schein (ibid.) in the book *Organizational culture and leadership*, recognizes three levels of the visibility and tangibility of cultural phenomena to observing parties.

These three levels, in order of declining tangibility, are *Artifacts*, *Espoused Beliefs and Values*, and *Underlying Assumptions* (Schein, 2010), but phenomena at all levels affect and are affected by one another:

Artifacts are the visible structures and processes within an organization. These are hard to discern on account of *intended* and *actual* usage. The Espoused Beliefs and Values concerns goals, strategies, and philosophies within the organization, also described as *espoused justifications*. Underlying Assumptions are the unconscious, taken-for-granted beliefs, perceptions, thoughts, and feelings. While being the least tangible it is described as the ultimate source of both values and action. In the figure below, the interconnection between the levels of culture is described, with a more detailed description about the levels being presented below the figure and on the following page.

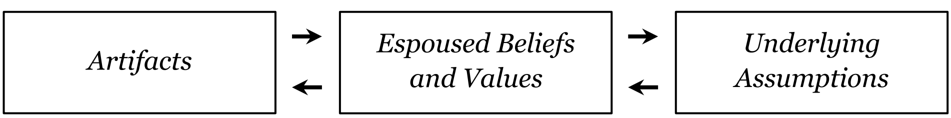

Figure 1. A variant depiction of the Levels of Culture as described by Schein (2010, p.26).

Artifacts mainly refers to the technology that is used by a group or groups of actors, but they can also include the stories told among groups in an organization (or organizations), and 'rituals', such as titles or ways of addressing other members as well as others within the organization(s). The artifacts can serve as a clue to understanding the underlying assumptions – but they do not tell the entire story as the assumptions drawn from only examining artifacts will inevitably be affected by the observers own personal thoughts and emotions. Thus, complete elucidation of all the artifacts associated with any technology in a large organization would be impossible, but with enough time spent within a group the meanings of artifacts become clearer and the most important artifacts become easier to identify (Schein, 2010).

Espoused Beliefs and *Values* is a term referring to the ways that groups within an organization view and rationalize strategies, common goals, and stances. These may include views of managerial decisions to adopt something that has never been tested before. For instance, to paraphrase an example given by Schein (ibid.), one can imagine a manager suggesting advertisement to combat a decline in sales. If this problem is solved by the suggested idea of advertisement and perceived as a good by the group, the perceived value of advertisements will turn this into a shared value or belief – and ultimately what is described as a shared assumption. However not all beliefs or values may undergo such a change because the solution might not have desirable measurable results, such as increases in revenue or perceived usability. It may have differing effects on different groups, in both measurable terms and in terms of less definable and abstract aspects such as aesthetic, ethical, or moral concerns. Schein (2010, p.29) describes this as a form of social validation, stating that: *"By social validation I mean that certain values are confirmed only by the shared social experience of a group. For example, any given culture cannot prove that its religion and moral system are superior to another culture's religion and moral system, but if the members reinforce each others' beliefs and values, they come to be taken for granted."*.

Basic Underlying Assumptions are the result of espoused beliefs and values that have come to be proven "right" on multiple occasions, whether it be in regard to the hierarchical differences within an organization, or solutions to manifested problems facing the organization or group. These basic assumptions can be regarded as beliefs that are so taken for granted that they become agreed elements of reality among members of a social unit. For example, a basic underlying assumption of a medical team is that a physician would never *deliberately* worsen a patient's condition. Such a notion would be considered inconceivable among healthcare professionals. These underlying assumptions are described as notions that are often not debatable or confronted, and hence exceedingly difficult to change, as described by Schein (2010, p. 31): *"To learn something new in this realm requires us to resurrect, reexamine, and possibly change some of the more stable portions of our cognitive structure [...] Such learning is intrinsically difficult because the reexamination of basic assumptions temporarily destabilizes our cognitive and interpersonal world, releasing large quantities of basic anxiety"*.

Rather than facing the anxiety of re-examining one's basic assumptions, actors tend to want their perception of events that are occurring to be congruent with their own assumptions. In an organizational setting this implies that workers within a group are generally most comfortable among other participants who share the same basic underlying assumptions, and very uncomfortable in settings where there is a different set of basic underlying assumptions (ibid.).

Beliefs and values of a group often originate from the leadership dealing with either internal or external problems. If the beliefs (or the values they generate) continuously work or are proven to be true (at least in the eyes of the group) they can be reinforced and further shared until they become basic underlying assumptions. These assumptions can then serve as defense mechanisms on both individual and group levels that hinder members' openness or willingness to consider other beliefs or values (Schein, 2010). Expanding on the concept of culture and group dynamics, Pickering (2001) presented the notion of *social agency*. While social agency is not a term that is used in the Organizational Culture framework, consideration of its impact along with the organizational culture would permit further examination of how phenomena such as DT affect, and are affected by, the agency of a group. Drawing on the earlier description of social agency, Leonardi et al. (2012, p. 14) summarize the concept as: "*[...] a group's coordinated exercise of forming and realizing its goals. [...] the practice of forming goals and attempting to realize them is a concrete operationalization of social agency*". While *material agency* is also discussed, it is considered to be devoid of any intention, *i.e* not acting to realize its own goals and is subsequently considered to have no goals of its own when compared to social agency (ibid.).

Successful alignment and understanding of how different actors view *Artifacts, Espoused Beliefs and Values,* and *Underlying Assumptions* could therefore strengthen groups' own social agency both internally and externally towards other groups. From a managerial perspective this could mean that along with the coordination of a project or implementation, additional coordination may be necessary in to ensure that the values, beliefs, and assumptions match between stakeholders - at least to such a degree that they are not misaligned. When considering coordination Okhuysen & Bechky (2009, p. 491) reason that: *"Coordination is enabled when the interdependence among parties, their responsibilities, and the progress on the task are all made visible through accountability. Additionally, coordination relies on the ability of interdependent parties to anticipate subsequent task related activity, that is, predictability. Finally, a shared conception of activities and how they are performed, or common understanding, also enables coordination."*. While the concepts of *social agency* and *coordination* might not be considered high priorities for exploration when considering 'regular' information systems, the ubiquity of IoT systems offers researchers opportunities to explore how the roles of associated individuals and groups may be affected by a system that is completely or partially invisible. If the interdependence of different groups becomes less pronounced when implementing and using an IoT-system, then the coordination between the various actors and actor-groups may potentially also be eroded, leading to a decrease in overall coordination (ibid.). To observe gradual changes over time a long-term study would be necessary, examining an IoT-system being used in practice, rationales of involved parties, and the processes involved in the changes.

Practice Lens perspective – Using the system

The effect of implemented technology when used by organizations is one of the core aspects of informatics. This means that multiple extant research domains are all collected under the umbrella term of 'IT-enabled organizational change' (Avgerou, 2000; Hirschheim & Klein, 2012). It has been shown that the efforts by organizations to become more digitalized also allow new opportunities for both actors and stakeholders at levels ranging from the single individual to a group level (Dellermann et al., 2017; Maedche, 2016), and while today's IS systems differ substantially from their earlier counterparts, the Practice Lens perspective remains a powerful tool for examining how work practices are affected by additional technology being implemented.

The Practice Lens perspective presented by Orlikowski (2000, p.404) is described as: *"[...] a practice lens to examine how people, as they interact with a technology in their ongoing practices, enact structures which shape their emergent and situated use of that technology."* Examination of technology usage as a process of enactment enables acquisition of deeper understanding of social practices and their roles in both how technology is used and resulting changes (ibid.). When examining the technologies in practice, which can entail any form of a technological artifact, they are considered to have both capacities to change and be changed. The changing of a technology in practice or how it is enacted depends on the actors using the technology, and how they experience some form of change to their own knowledge, awareness, motivation, time, circumstances, or the technology itself. Such change of technologies in practice occurs through human action, which is considered the process through which all social structures are changed (Orlikowski 2000, p. 411), and is therefore a crucial aspect to consider when examining the changing of practices.

In the Practice Lens perspective, a technology is never considered to be fully completed or 'stable'. This reasoning is expanded on by Orlikowski & Iacono (2001) regarding the black-boxing of technology, meaning that it is considered a background aspect or one that is a constant, never-changing entity. However, for the sake of simplicity, the technology may still be viewed as temporarily stable in order to study it in a fixed point in time, as long as it is not assumed to be constant.

When using the Practice Lens perspective framework in the studies underlying this thesis, one of the aspects that my colleagues and I (hereafter we) focused on was how change related to knowledge affected the willingness to enact change, and how this knowledge further came to alter enactment. Similar changes are not related to knowledge but can take the form of directives by managers regarding usage and may depend on the change offered by the technology itself and how it is viewed by the actor(s) using it (Orlikowski, 2000).

Because of this potential for change through enactment, there is also a potential for the usage to change the interpretive schemes, such as norms or structures. The technology may also render previous knowledge obsolete – like how things are 'supposed to work' through changing of work practices and processes – where actors may come to see how certain prior knowledge is no longer of any use.

Recognizing that multiple factors may affect technology in practice and the ways that technology is enacted, Orlikowski (ibid.) describes three degrees of enactments that may be addressed using the Practice Lens, in terms of the technologies in practice and how they are handled by the actors involved. She states that the enactment of change that appears in terms of either technology or practices is usually related to the conscious actions of individuals, whereas consequences for structures much more often can be seen as unintended results of the conscious choices. This is an important aspect to consider when using the Practice Lens, but also when considering use of IoT systems to facilitate change. The three degrees of enactments are *inertia*, *application*, and *change*, described by Orlikowski (2000, pp. 421-423) as follows:

- *Inertia* refers to actors deciding to use technology in a way that keeps the previous status quo with little or no change in organizational structures or processes that are being performed or enacted among users, linked to both skepticism and a lack of understanding of the technology.
- *Application* refers to usage of technology to either refine or augment the current way that current processes are performed – resulting in both the reinforcement and the enhancement of the status quo, linked to understanding the technology at hand and motivation to change.
- *Change* here refers to an enactment where actors' use of technology significantly alters their way of performing their work or processes, resulting in transformation of the structural status quo within the organization, linked to high degrees of understanding and motivation to further change and abandon previous practices.

These enactments are not considered to be static but can come to change based on how technologies are enacted in practice and reasoned about by the actors involved. They are not to be considered exhaustive or comprehensive, but rather as a way to view and understand changes in practices (Orlikowski, 2000). To accurately understand and portray how enactments are taking place, a researcher should consider both observations and views of relevant actors (as expressed, for example, in interviews) to explore how technology-in-practice and its usage affects them. The interactions may be particularly complex and difficult to encapsulate when examining IoT systems due to their ubiquity and the multiple further interactive disruption changes they may trigger.

This is discussed by Karimi & Walter (2015) where it is hypothesized that digital technologies like IoT-systems are described as being inherently disruptive, as they would to some extent require major changes within the organization. The implementation of an IoT-system could result in a change to the currently described status quo within the organization, should it be considered a disruptive technology (Vial, 2019). Regardless of how the previous technological notions has been described, the implementation of an IoT-system would likely usher users to attempt in enacting *change* regarding their technology-in-practice, despite the possibility of lacking the tools (*e.g* knowledge or understanding) to do so. The change aspect would to some degree have to be a common theme throughout the team or organization for it to be sustainable. When using this framework in Study 2, it was combined with an additional theory, to extend the capacity for explanation down to a more micro-level perspective. This was done to examine how knowledge and system understanding was generated, communicated, or understood among the involved actors. In the examination of overarching aspects using the Practice Lens perspective, a more actor-centric concept – such as that of 'digital mindset' may account for individual aspects relating to the actors' own perceived and stated understandings of the system.

The digital mindset of an actor is regarded as being based on two general and individually held beliefs: *"The first belief is self-oriented and reflects individual beliefs about the extent to which one's personal ability to learn and use new technologies is fixed or malleable. The second belief is situation-oriented and reflects beliefs about the extent to which the context of technological change is composed of finite resources that must be competed for- versus expandable resources in which all parties have the opportunity to gain."* (Solberg et al., 2020, p. 107). These beliefs are characterized as having a fixed vs a growth belief and a zero-sum vs. an expandable-sum belief – where the combination of held beliefs work together to form a digital mindset (ibid., 2020). While the concept of digital mindsets is not related to the Practice Lens perspective, it can be used as a way to gauge how strongly actors are affected by extant beliefs or internal beliefs about themselves – and allow additional in-depth discussions regarding effects of structures within an organization.

The disruptive aspect of digital transformation can happen either rapidly or as a process slowly unfolding over time, making the visibility of the disruption (or transformation) range from a something that is immediately visible, to something that takes additional time to study, which may then affect the visibility of any potential disruption (Karimi & Walter, 2015). Use of both the 'digital mindset' concept and Practice Lens perspective allowed us to discern changes and effects on organizational practices based on the technology-in-use, and also to theorize regarding concepts such as how to create knowledge or facilitate a change in the digital mindset of the actors using a system during our longitudinal study.

Research design

In this chapter I explain the data collection and analysis procedures applied in the studies underlying this dissertation. The following section, 'Positioning of the research' justifies the methodological choices and explains why I deemed them to be most suitable for examining the cases and objects I studied. Following my positioning I further outline my approach to the collection and analysis of the presented data in the appended papers. As I describe both my own choices and rationales, as well as those of fellow co-authors, I will refer to myself both as 'I' and as 'we' when representing the author team as the first author.

Positioning of the research

In positioning my own research, I will discuss the aspects that I have found to be important influences on my methodological choices and overall ontology and epistemology of the performed research. These aspects are my own views on IS-research, how this has come to influence the way I approach research, and how this approach has brought me to interpret the conclusions presented later in the dissertation. I find the IS-field to be a fascinating one compared to other fields of study – as it is my belief that in order to become a competent IS-researcher one has to be knowledgeable in multiple fields. To fully understand the effects of information systems and their effect on people and organizations, the researcher should have an interest in multiple different fields, ranging from business-science, organizational-science to sociology and psychology, which also becomes evident in terms of the diverse backgrounds of early IS-researchers. To me, this is very eloquently put by Allen S. Lee, when stating that: *"[...] research in the information systems field examines more than just the technological system, or just the social system, or even the two side by side; in addition, it investigates the phenomena that emerge when the two interact. This embodies both a research perspective and a subject matter that differentiate the academic field of information systems from other disciplines."* (Lee, 2001, p. iii).

It is this interaction between technological and social systems where IS-research should focus to understand the increasingly complex and ubiquitous systems that surrounds us on a daily basis. Lee argues that models developed outside the IS field may have poor capacities for examining these interactions as they are not specifically designed to address them (ibid.). To some extent I share this belief when information systems are specifically examined. However, I also believe that ignoring models or knowledge gained from earlier research (for being outdated), or research within other fields than that of informatics would have a detrimental effect on future knowledge generation and lead to researchers rooted in different disciplines 'reinventing the wheel' many times over.

I view the role of researchers, and how they relay knowledge, as being similar to that of an investigative reporter, as I believe that in generating knowledge about people they need to interact and participate in interviews with people in the areas that they study. When addressing the interaction between the social and technological during the research I adopted a firmly interpretive approach, recognizing that, *"The meanings that human subjects create, communicate and hold are part and parcel of the real world that a social scientist perceives as the subject matter under investigation"* (Lee & Baskerville, 2003, p. 228). This view consistently informed the data collection, processing and analysis as well as the subsequent formulation of arguments in the studies and discussion part of this dissertation. The overall aim of the studies was to enhance understanding of how actors and organizations come to act and interact in creating value through the implementation of an IoT system. The interpretative stance was very helpful as the actors had diverse backgrounds, educational levels, and understandings of the focal technology.

When considering ontological aspects of using an interpretative philosophy, it means that the researcher to some extent assumes that key aspects of the social world – *i.e.*, the relationships between individuals, organizations, and divisions of work – are not static. Instead, the social world is being constantly produced and reinforced by people as they continuously act or interact with each other and the world. This is further summarized by Orlikowski & Baroudi (1991, p. 15), as: "*Organizations, groups, social systems do not exist apart from humans, and hence cannot be apprehended, characterized, and measured in some objective or universal way"*. In contrast to positivistic researchers, who may seek to 'discover' what could be categorized as an objective social reality, interpretivist researchers believe that reality can only be interpreted (ibid.).

An obvious consequence of adopting an interpretivist perspective in my research was then to apply more qualitative than quantitative methods, although an interpretivist stance should not be considered to be synonymous with, or a requirement for, qualitative research (Klein & Myers, 1999). However, in interpretative research it is essential to seek a holistic understanding of a studied system, rather than merely an understanding of individual parts, and the ability to move between the holistic view and more detailed views (Goldkuhl 2012). Similarly, both ontological and epistemological aspects are intimately connected within interpretivism, as the understandings or meanings that constitute 'knowledge' are such essential elements of the ontological assumptions of the world's constitution (ibid). In my own research, I make no nomothetic statements regarding either technology or human behavior. This is common in interpretivist research (Schutz, 1962-1966, p.48), and differs from that of, research rooted in grounded theory, which aims to identify generalizable laws that are independent of cultural-historical specificity.

Data Collection and Analysis

In this chapter the data collection and data analysis undertaken as a part of this dissertation is described and detailed regarding three studies resulting in four research papers. The collected and analyzed data has been divided into *"The CleanCo Study"* (Study 1 – Resulting in Papers 1 & 2), *"The MuniciClean Study"* (Study 2 – Resulting in Papers 2 & 3), and *"The Scoping Study"* (Study 3 – Resulting in Paper 4). Data collected from these studies has later been analyzed and presented based on the theoretical frameworks used for the analysis.

Data Collection

The qualitative data used in this dissertation has been generated over a period of four years. The semi-structured interview-method used for Papers 1, 2 and 3 has been identical in its execution - the separation merely a temporal one.

The semi-structured approach to the interviews was deemed a natural choice for these studies, as semi-structured interviews allow for open-ended questions, where different avenues of inquiry could be pursued based on the responses given (Mathers et al., 1998). A semi-structured approach also allows a more relaxed setting than a fully structured approach. Longhurst (2003) describes this as adoption of a more conversational style of interview that still maintains clarity for respondents that it is more than just a chat. The relaxed setting of the interviews aided me, as the interviewer, to gather data in an informal manner. It also provided a desired ability to direct the conversation towards interesting aspects depending on the statements that were made. The semi-structured interview style has been described as being superbly suited for situations where probing open-ended questions needs to be asked to understand the independent thoughts of each individual, as well as providing maximum latitude to pursue any leads that could be useful (Adams, 2015).

A chain sampling method to gather respondents was used in both the CleanCo study and the MuniciClean study, because of the small number of viable interview candidates. The chain sampling method is recommended to be used with small and dispersed populations and allow for establishing contact with key individuals relating to the research, particularly effective in terms of sensitive topics, or when it's hard to identify employees through work rosters (Ritchie et al., 2013). Chain sampling is the gathering of additional interview subjects through contacts of key respondents – which in the case-studies would mean that access was gained to additional respondents through the Building Manager in Study 1 and the Project Manager in Study 2. This method of sampling proved to be an effective one, and was used in Paper 1, 2 and 3. The chain sampling has been questioned on account of the connection that exists between the respondents, meaning that its usage could mean a lack of diversity among respondents in a non-work setting (ibid.).

Ritchie et al. (2013) regard this as problematic but suggest that the diversity issue can be mitigated by asking the participants to suggest new respondents who meet set criteria, but are otherwise dissimilar from themselves, which would be beneficial in a social setting for this type of sampling. For instance, in my studies, one maintenance worker could be asked to suggest other maintenance workers who might not agree with them about certain relevant matters. In this context it is important to note that this type of chain sampling can be used for statistical inferences regarding relationships within a population (Goodman, 1961). Earlier research also argue that the chain sampling is a method that uniquely fits the social sciences particularly well as it allows for sampling of natural interactional units (Coleman, 1958).

All the respondents in every interview were informed about the purpose of their interview in advance, and it was explained that they would be anonymized, but excerpts or quotations from their interview could be used for scientific reports and publications. They were informed that they would be recorded for the interview (if they consented), and any audio recordings taken would only be used for the purpose of transcription, and subsequently destroyed. Finally, the participants were informed that they could revoke their consent at any point, and that anything relating to them would be erased from the data. No respondents opted out in any of the studies.

Study 1 – The CleanCo Study (Research Papers 1 & 2)

The initial study, performed in 2018, focused on a private organization designated BuildingCo, which was using a new way of cleaning involving use of a third-party IoT product to enhance custodial maintenance in a large recreational facility. Through Umeå University, which had previously been in contact with the manager, contact was established via phone. The potential for conducting a case study was proposed and discussed in the phone call, and upon agreement a date was set up for an initial interview.

This date coincided with a product meeting with BuildingCo later in the day, which also involved additional stakeholders related to the IoT system. These stakeholders included representatives of CleanCo – a cleaning organization hired by the BuildingCo manager to perform custodial maintenance, and SystemCo – a third-party developer providing the system as a ready-to-use product. Before the initial meetings and interviews a framework for the study was decided, with a desired capacity to examine the effects (both visible and invisible) of the system's implementation on the actors and other stakeholders. For this, the TFR by Orikowski & Gash (1994) was used, and our interview questions were designed in broad terms to gain initial insights into what the organization and people within it were hoping to achieve.

The initial meeting that had been set up by the manager for BuildingCo allowed for me to introduce myself to the various stakeholders and actors, explain the study that was being conducted, and to facilitate further contact with the third-party developer for a face-to-face interview at the same time. After the initial meeting the representatives from SystemCo were interviewed regarding how their company aimed to generate value from the IoT-system, and how it had been received by BuildingCo, CleanCo, and other similar companies.

After the interviews with the sales representative and product owner, I was also directed to the technical product manager for SystemCo – allowing for a more in-depth interview into technical details as well as how they sought to create value on a more overarching scale. The initial meeting also included both of the Team-Leaders from CleanCo which also acted as system managers. Interviews were scheduled with both the Team-Leaders and additional cleaners that were using the IoT-system. Team-Leader one had the most hands-on experience with the system, so a follow up interview was performed with them, as well as a group interview and secondary interview with Team-Leader two.

The interviews were combined with observations of how the maintenance workers used the system, and how it changed their way of performing their work. The interviews and observations spanned between December -2017 and February -2018, and every interview was performed in person, except for a phone interview with the Technical Product manager for SystemCo. The interviews are sorted based on actors and their roles as stakeholders and presented in Table 1 below. The data collection consisted of interviews, observations, meetings, and the gathering and analysis of material connected to the IoT-system and actors.

Study 1 – The CleanCo Study			
ACTOR(S)	**GROUP(S)**	**COLLECTED DATA**	**HRS.**
Building Manager	BuildingCo	Meetings/Interviews Transcription & Analysis Presentation	2h 6h 2h
Presentation w. Stakeholders and five Participants	BuildingCo, SystemCo, CleanCo	Meetings / Interviews Transcription & Analysis Observations	4h 15h 2h
Group interview w. Product Owner and Sales Rep.	SystemCo	Meetings/Interviews Transcription & Analysis	1h 4h
Technical Product Manager	SystemCo	Meetings/Interviews Transcription & Analysis	1h 2h
Team-Leader 1 (System manager)	CleanCo	Meetings/Interviews Transcription & Analysis Observations	2h 6h 2h
Team-Leader 1 w. four additional cleaners	CleanCo	Meetings / Interview Transcription & Analysis Observations	1h 6h 3h
Team-Leader 2	CleanCo	Meetings/Interviews Transcription & Analysis	1h 3h

Table 1. Table displaying actors, actor-group, data collected and the estimated time during Study 1.

Study 2 – The MuniciClean Study (Research Papers 2 & 3)

The second study started in April -2018 when I was introduced to the municipal Project Manager by the university – as part of a larger research project regarding smart cities. The municipality was in the planning phase of testing how an IoT-system, similar to the one in the CleanCo study, might work for them when utilized in a municipal setting. The Project Manager was positive towards the study, facilitating contact with additional stakeholders. These stakeholders consisted of the Project Manager, the maintenance workers from MuniciClean that were using the system, and the District Managers within the municipality, whose job it was to oversee the maintenance workers. These were the initial involved stakeholders in Paper 2, because of the project's early phase. As the project progressed, an additional stakeholder became involved, this stakeholder was SysDev – a third-party developer hired by the Project Manager to produce the coding and layout of said system and making changes based on the input from the stakeholders, *i.e* the maintenance workers, the District Managers, and the Project Manager. Although it was still early in the project as Paper 2 was formulated, the initial interviews gave open and honest reflections from all stakeholders. Because of the willingness from the participants to speak honestly about the aspects they had encountered the collected data became both rich and saturated throughout the study.

In the early phase of this study our aim was to explore differences between the private organizations addressed in Study 1 and actors from MuniciClean involved in the municipal project. As the managers discussed their views surrounding the perceived benefits of the IoT-system, one aspect that came up several times was that maintenance work was considered a low status job, and that the IoT-system was a way of increasing the status for workers through technology. Considering the argument to be an interesting aspect, we decided on using the "Organizational Culture" framework by Schein (2010) as the theoretical framework when making our comparisons. The Organizational Culture framework let us study artifacts, shared beliefs, and underlying assumptions within the organization to better understand how organizational structures could come to affect implementation efforts. Comparing the thoughts of maintenance workers that were successfully using an IoT-system in their current work (CleanCo), and maintenance workers that were about to have one implemented also allowed us to theorize further regarding how a difference in cultures might be a contributing factor in terms of how the maintenance workers stance on the system and its implementation. The initial part of the MuniciClean study, resulting in Paper 2, totaled thirteen interviews – with five of these interviews being related to the municipality, and eight from our previous case of CleanCo. Contrasting the two cases, we could observe certain similarities in terms of the makeup of the maintenance worker-groups, yet they differed quite a bit in terms of the trust regarding the system.

In formulating Paper 2, and continuing with the study of MuniciClean, monitoring the municipal project over two years enabled us to detail the project in a longitudinal fashion as it progressed. In addition, as the MuniciClean study was progressing from the initial planning phase to the implementation phase a scoping study was also performed – while still observing and interviewing actors and stakeholders to map possible changes in their views with time.

The interviews themselves were scheduled around availability, where the Team-Leader for the maintenance workers was interviewed first – along with an initial observation of how their work was being performed without the system. Further, one of the maintenance workers that were going to use the new IoT-system was interviewed as well around the same time. During the fall of 2018, further interviews with the maintenance workers were conducted, as the system had now been implemented and initial testing had commenced. When interviewing the cleaners, the interviews were followed by observations regarding system usage. Interviewing the cleaners beforehand was to gather insight into their reasoning throughout the process. This was further done while observing and following day-to-day activities spread out over time, combined with additional interviews at different stages of the process. Since we had the opportunity to study the transformation over time, we aimed to analyze the data in its entirety, and also in a way where we could examine effects on the organizations and the extant practices.

As the IoT systems' capacities to enact digital transformation were becoming more apparent, we decided to use the Practice Lens perspective presented by Orlikowski (2000), along with a grounded approach in analysis of our interviews in the second part of Study 2 (presented in Paper 3). This also allowed us to expand analyses of the issues considered in the previous Papers (1 and 2) while also focusing on the actors' views regarding implementation and organizational aspects. As the Scoping Study had been completed while following the municipal case, the observations, gathered data, and interviews were now spanning over a period of two years, and with the municipal project coming to an end, so was the data gathering phase of our study. Apart from individual interviews a focus group interview was performed with five cleaners, two of whom were using the IoT-system and three of them not using it but still remaining within the same team. They described their own thoughts as well as information that had been relayed to them from colleagues and managers. The project spanned from April -2018 to April -2020, with additional interviews being performed with the management during early -2021. All the interviews, sorted by their respective group of actors are presented in Table 2 titled 'Study 2 – The MuniciClean Study'. The data collection for this study consisted of in-depth interviews, observations, informal interviews, meetings, and the gathering and analysis of material connected to both the IoT-system and the involved actors.

Study 2 – The MuniciClean Study				
ACTOR(S)	**GROUP**	**COLLECTED DATA**	**HRS.**	**#**
Project Manager	Managers	Meetings/Interviews	10h	4
		Transcription & Analysis	40h	
District Manager 1	Managers	Meetings/Interviews	2h	1
		Transcription & Analysis	6h	
District Manager 2	Managers	Meetings/Interviews	6h	3
		Transcription & Analysis	30h	
		Presentations	1h	
		Observations	1h	
CEO	SysDev	Meetings/Interviews	3h	1
		Transcription & Analysis	6h	
HCI - Expert	SysDev	Meetings/Interviews	1h	1
		Transcription & Analysis	3h	
Team-Leader	Cleaners	Meetings/Interviews	5h	3
		Transcription & Analysis	15h	
		Observations	3h	
Cleaner 1	Cleaners	Meetings/Interviews	4h	2
Cleaner 2		Transcription & Analysis	12h	1
Cleaner 3		Observations	2h	1
Focus Group w. five additional Cleaners	Cleaners	Meetings/Interviews	1h	1
		Transcription & Analysis	4h	

Table 2. Table displaying actors, actor-group, data collected, estimated time and the total number of interviews performed (#) with each actor during the longitudinal Study 2.

Study 3 – The Scoping Study (Research Paper 4)

The data collection for the third study is quantitative in nature and was collected with the purpose of performing a 'scoping study' - a method which is primarily utilized within the medical field. This shift in data collection method and analysis was deliberate – selected in order to experiment around different ways to search for information and spot gaps in extant literature. The data collected in Study 3 was in the form of article metadata from Scopus – a database which is a part of the Elsevier publishing company. Describing themselves as 'The leading abstract and indexing research discovery solution for academia, business and government' (Elsevier, 2021), and being used by practitioners and researchers alike, Scopus served as a base for data collection representative of the academic field. For this study only peer-reviewed journals were selected to be part of the data-sample. The rationale for this was that publishing processes of journals is considered by academia to be more rigorous than conference papers (Senn, 1998).

In order to get a relevant selection of data for later analysis, any articles older than 2014 were deemed to be either far too conceptual or in the early stages of IoT implementation and were thus filtered. Similarly, any upcoming articles that were indexed but not published were also filtered, in order to make sure that only relevant and peer-reviewed articles would remain among the dataset for later analysis. When searching in the Scopus database, one can delimit themselves to subject-fields, and since my study examined the social sciences – the delimitation aspect became the primary method of finding article-journals which would fit my criteria. The subject-fields chosen among the available ones in Scopus was ‘Social Science’, ‘Business, Management and Accounting’, Psychology and ‘Arts and Humanities’. The choice of these particular fields was made in order to account for any cross-disciplinary papers, and to catch eventual articles that would still be of interest in terms of the keyword analysis. In the figure presented below, the final database inquiry used to generate the articles that were later processed is shown. It details the keywords along with the commands to execute the search according to the described criteria above.

```
( TITLE-ABS-KEY ( iot ) OR TITLE-ABS-KEY ( "Internet of Things" ) ) AND PUBYEAR > 2013
AND PUBYEAR < 2020 AND ( LIMIT-TO ( SUBJAREA , "SOCI" ) OR LIMIT-TO ( SUBJAREA ,
"BUSI" ) OR LIMIT-TO ( SUBJAREA , "ARTS" ) OR LIMIT-TO ( SUBJAREA , "PSYC" ) ) AND (
LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )
```

Figure 2 A depiction of the search query used in Study 3 for delimiting relevant articles.

For additional clarification, the flowchart from Paper 4 is presented below, showcasing the data collection and selection process. The initial dataset is presented in the leftmost white square, and the curating of the papers is shown moving right, with the number of removed articles shown in the box below each respective selection phase. The grey box in the bottom left shows the final number of articles that were later selected for Keyword analysis.

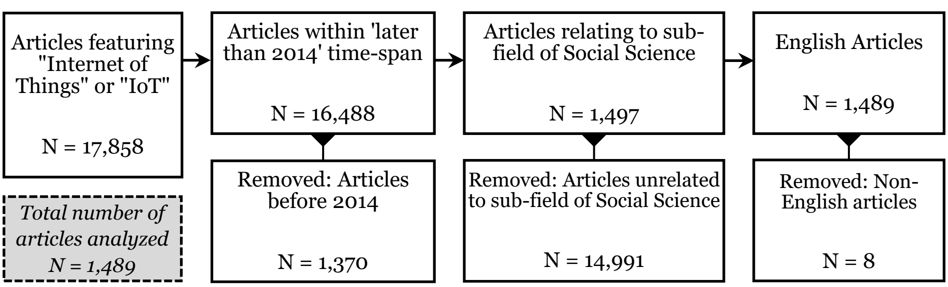

Figure 3. A flowchart explaining the selection process for which articles to analyze during the scoping study, showcasing criteria, and how the number of articles were systematically curated from 17,858 articles to 1,489 articles.

The initial search generated 17,858 articles, and after accounting for articles newer than 2014, related to the social science field of research, and in English – 1,489 articles remained for further analysis. 786 of these articles were from the subject field of Social Science, 730 from Business, Management and Accounting, 85 from Psychology, and 84 from Art and Humanities. As stated in Paper 4 the discrepancy when comparing the number of articles (1,489) and the number of articles when adding up the articles within each subject-field (1,685), can be explained by some articles being indexed in multiple categories, and because of this they would show up multiple times before being removed as duplicates prior to the analysis. From this selection the 1,489 articles were then downloaded and analyzed by a software named VOSviewer, which will be further explained below under *data analysis* for Study 3. The analysis yielded one final dataset that was ultimately used for additional analysis - forming the paper. This dataset was the keywords that were existent in all the selected papers. These keywords were then further curated, removing near-identical keywords in favor of the most used one, with the example that is given in the article being 'Smart City' vs. 'Smart Cities'. The rationale for the omission of similar keywords was because of the similarities in the connections formed, meaning that their inclusion would ultimately be redundant in its nature.

Data Analysis

Analysis of the data has been performed using the three theoretical perspectives described in the previous chapter – the Technological Frames framework, the Organizational Culture framework, and the Practice Lens perspective. As the data analysis for each individual research paper is outlined within the respective paper, along with the descriptions of the frameworks, this section will serve as a summary for the data analysis process of each paper. Study 1 relates to Paper 1, whereas Study 2 relates to both Papers 2 & 3, and the data analysis has therefore been split into two sections, one describing the data analysis in Paper 2 and the following section describing Paper 3. Study 3 relates to Paper 4, describing the analysis in greater detail, as the analytical framework has not yet been described.

Study 1 – The CleanCo Study (Research Papers 1 & 2)

In the first paper the analysis was made using the of technological frames framework (TFR) by Orlikowski & Gash (1994). TFR is described by the authors as: "[...] *A systematic approach for examining the underlying assumptions, expectations and knowledge that people have about technology*" (Orlikowski & Gash, 1994 p. 174). The rationale for using this specific framework to analyze the data was the ability to allow for us to examine where overlaps or differences could be spotted early on during the interviews with the various stakeholders and actors and also as a way of examining the concept of congruence and incongruence further.

The theoretical categories that are presented within the framework consist of 'Nature of technology' – what IoT is and what it does, 'Technology Strategy' – What IoT adds, and 'Technology-in-use' – How IoT will be used (Orlikowski & Gash, 1994). We interviewed the respondents based on these theoretical categories to see whether or not there existed congruence among the various involved parties. For the coding of the data material, we went through each of the transcribed interviews, and coded the text based on how the statements related to the TFR framework.

This is described in greater detail in Paper 1, giving examples of how certain quotes and statements were differentiated from one another, and the rationale behind the differentiation. As described by the cited authors, the overlap or 'shared understanding' of stakeholders with similar ideas about a system is referred to as *frame congruence*, while *frame incongruence* refers to mismatches in these understandings or interpretations of stakeholders. Such incongruence has been theorized as potential causes of trouble or conflicts in the development, implementation and/or use of the system (ibid.). In analyzing the data using this framework we were able to both spot areas where there seemed to be a shared congruence, as well as other instances where an incongruence was discovered amongst the actors.

Study 2 – The MuniciClean Study (Research Papers 2 & 3)

In our second paper – including both the private and the public organization, we used the Organizational Culture framework by Schein (1988; 2010). As this paper examined two organizations this framework proved a succinct way of comparing the two in terms of differing social factors. The Organizational Culture framework looks at three aspects: artifacts, values, and underlying assumptions. *Artifacts* are visible structures and processes, *values* are things as strategies, goals, and philosophies, and the *underlying assumptions* are the unconscious, taken for granted beliefs, habits of perception and, thoughts and feelings (Schein, 1988 p. 9a). Statements by the interviewed stakeholders were interpreted by using the framework to code their statements in terms of conceptions of the system that could affect its reception.

In the study reported in Paper 3 we used the Practice Lens perspective developed by Orlikowski (2000). This facilitated study of the enactment and re-enactment of the organizational life through human-technology action and interaction spanning over a longer period of time. While we were using this theoretical framework to analyze our data, we furthermore followed a grounded approach, in which the collected data were further analyzed in three stages, as follows. First, transcripts of all the interviews were read through and coded using open coding.

This resulted in 132 codes, with each coded segment given a time stamp showing the project phase it related to, and role of the interviewee so statements of different kinds of stakeholders could be easily distinguished. Certain codes were only used once, such as "Big Data", "agile work" and "uncertain strategy", whereas others appeared more often and were used several times, for example "changing work" and "uncertainty".

In the second step, the initial 132 codes were sorted in descending order of number of occurrences in the dataset. At this point we also examined codes that appeared together and grouped them accordingly. For instance, the code "stress", used 14 times in total, appeared alongside "increased workload" in 10 of those instances, and seven occurrences of "negative impact". Therefore, the "increased workload" and "negative impact" codes were treated as properties of the "stress" code. In addition, the empirical material was examined from perspectives of each of the stakeholder groups, so again, when addressing "stress", for example, we also noted if it occurred in both managers' and cleaners' accounts of events. After this round of coding and grouping codes, the original 132 codes were condensed into 24 codes.

In the final step, the remaining 24 codes were discussed and grouped into five themes (see Table 2) denoting the scope for transformational action enabled by use of the IoT system, as observed in practice, at both the organizational level (as expressed mainly by the Project Manager, District Managers, and System Developers), and individual worker's level (as expressed mainly by the Team-Leader and cleaning crew).

Study 3 – The Scoping Study (Research Paper 4)

The third study and subsequently the fourth paper was intended to expand from the previously small scale of individual case-studies, instead moving to capture the broader aspect of social-science studies itself. Arksey & O'Malley (2005, p.21) describes the depth examined in a scoping study as; *"The extent to which a scoping study seeks to provide in-depth coverage of available literature depends on the purpose of the review itself"*. As this study was intended to give a snapshot of the current discourse trends among researchers, the depth of the analysis reflected this goal, functioning primarily to provide a discussion about future research. The analysis itself was performed using VOSviewer, a software created to allow for constructing and visualizing bibliometric networks. While measuring Co-Citations is one of the primary aspects of VOSviewer, the software also allows for examining keyword mapping and comparison, measuring the strength between keywords, and which keywords are frequently used together (CWTS, 2021). The keywords connected to the selected 1,489 articles were analyzed and presented in a network-map which can be seen in the related Paper 4.

In this map, the keywords that were frequently used together became grouped into clusters based on their relevance and connection to one another. These clusters were unnamed, instead grouping the clusters based on connection and connection strength through occurrences within the literature. Each cluster was examined individually and assigned a theme based on what the literature of each cluster entailed. Deciding on the depth of analysis I chose to weigh the aspects of 'relevance' compared to 'rigor' as described by Senn (1998) – with the intention of creating an overview of the field. In doing so, the goal was to simplify discussed areas in terms of IoT within the social sciences for practitioners and researchers alike. By measuring the relative strength of the connections between keywords, examining the clustering in the metadata of the 1.489 articles, and select reading of the top cited articles within each cluster a thematic overview was performed. Following this overview, the scope, keyword analysis, and discussed challenges were then presented within each of the emerging themes. The keywords and their related themes are shown in Table 3 below, based on the literary analysis.

Study 3 – Scoping Study (Keyword Occurrence)			
KEYWORD:	**ID:**	**THEME:**	**OCCURRENCE:**
Industry 4.0	A-1	Organization	65
Sustainability	A-2	Organization	43
Innovation	A-3	Organization	40
Sustainable Development	A-4	Organization	34
Decision Making	B-1	Logistics	54
Embedded Systems	B-2	Logistics	50
Manufacture	B-3	Logistics	41
Radio Frequency Identification	B-4	Logistics	39
Supply Chains	B-5	Logistics	36
Smart City	C-1	Infrastructure	77
Automation	C-2	Infrastructure	49
Energy Efficiency	C-3	Infrastructure	36
Wireless Sensor Networks	C-4	Infrastructure	36
Intelligent Buildings	C-5	Infrastructure	29
Big Data	D-1	Technology	121
Artificial Intelligence	D-2	Technology	43
Cloud Computing	D-3	Technology	40
Information Management	D-4	Technology	39
Data Mining	D-5	Technology	34
Education	D-6	Technology	30
Human	D-7	Technology	29
Network Security	E-1	Protection	48
Security	E-2	Protection	44
Data Privacy	E-3	Protection	39
Privacy	E-4	Protection	37

Table 3. A table displaying the most common keywords relating to IoT papers, out of 1.489 articles, using VOSviewer on the dataset.

In Table 3, the results of the initial keyword analysis are presented – based on the 1,489 articles that were used along with VOSviewer. The data that is represented showcases the most common keywords, grouped together based on the frequency that these keywords were used in conjunction with one another. 'ID' initially functioned to distinguish keywords and their correlation, but after the formation of 'Themes' the 'ID' tag was no longer necessary; however, it is still presented for transparency on how each of the keywords were handled and categorized when examining them further. The color-coding serves no purpose outside that of easier identification for each of the themes because of the multiple keywords and themes. The resulting analysis of the scoping study have been presented with the two most cited articles within each thematic cluster below. In Paper 4 the top five articles are presented, with Table 4 below aiming to showcase how the analyzed list was presented within the paper. The colors of each of the articles in the table corresponds with each of the describes Themes in Table 3, featured on the previous page. The colors below, in descending order, represent 'Organization', 'Logistics', 'Infrastructure', 'Technology', and 'Protection'.

Study 3 – Scoping Study (The two most cited papers within each theme)			
ARTICLE:	**AUTHOR(S):**	**JOURNAL, YEAR:**	**#C:**
The Internet of Things (IoT): Applications, investments, and challenges for enterprises	Lee, I., Lee, K.	Business Horizons, 2015	349
Business models for the Internet of Things	Dijkman, R.M., Sprenkels, B., Peeters, T., Janssen, A.	International Journal of Information Management, 2015	109
Smart manufacturing: Past research, present findings, and future directions	Kang, H.S., Lee, J.Y., Choi, S., Kim, H., Park, J.H., Son, J.Y., Kim, B.H., Noh, S.D	International Journal of Precision Engineering and Manufacturing - Green Technology, 2016	203
The Future of Retailing	Grewal, D., Roggeveen, A.L., Nordfält, J.	Journal of Retailing, 2017	91
Smart tourism: foundations and developments	Gretzel, U., Sigala, M., Xiang, Z., Koo, C.	Electronic Markets, 2015	217
The role of big data in smart city	Hashem, I.A.T., Chang, V., Anuar, N.B., Adewole, K., Yaqoob, I., Gani, A., Ahmed, E., Chiroma, H.c	International Journal of Information Management, 2016	170
Significance and Challenges of Big Data Research	Jin, X., Wah, B.W., Cheng, X., Wang, Y.	Big Data Research, 2015	205
The role of big data in smart city	Hashem, I.A.T., Chang, V., Anuar, N.B., Adewole, K., Yaqoob, I., Gani, A., Ahmed, E., Chiroma, H.c	International Journal of Information Management, 2016	170
Regulating the internet of things: First steps toward managing discrimination, Privacy, Security, And consent	Peppet, S.R.	Texas Law Review, 2014	75
Low-energy security: Limits and opportunities in the internet of things	Trappe, W., Howard, R., Moore, R.S.	IEEE Security and Privacy, 2015	65

Table 4. An abridged table from Paper 4 showcasing thematic articles for each of the clusters, along with their number of citations (#C) at the time when the study was performed.

Research papers

In this chapter I present and summarize the four papers that have been appended to this dissertation. Three of which are conference proceedings presented at IFIP and HICSS, with the fourth being a journal article currently under review. Each of the four papers aim to study IoT and its role as a transformative technology, gauging the effects on both actors and actor-groups. Below in Table 5 the four studies are presented as a summarization, describing the research questions, theoretical framework, the methodology and the contribution.

Summary of research papers				
	Paper 1	**Paper 2**	**Paper 3**	**Paper 4**
Research question	What are the challenges and opportunities associated with introducing IoT in the workplace?	Given the ambiguity and complexity of sensor-based systems, how is system value and purpose conveyed, and which factors determine the susceptibility of adoption among individual workers and teams?	How can the process of organizational digital transformation be conceptualized and understood in the context of IoT implementation and from the perspective of different stakeholders?	What areas are being addressed within the social science subject-field of IoT-literature in research journals and where can further social science research stand to contribute?
Theoretical framework	Technological Frames	Organizational Culture	Practice Lens perspective	Scoping-Study
Methodology	Qualitative	Qualitative	Qualitative	Quantitative
Contribution	This research contributes to IS by showing an IoT-system in use through a case-study on early adoption and testing. It displays how the system has had an effect on the different actors within three different organizations, with added suggestions in terms of usage and added value through IoT-systems	This research shows how different organizations compare in terms of organizational culture. It shows how the different mindsets between different actors contributes to the willingness to use technology, and also what aspects that are necessary to consider in terms or IoT or sensor-based technologies within organizations	This research details a longitudinal implementation of an IoT-system, explaining how the process affected different actors within the organization. It contributes by giving a longitudinal perspective on implementing an IoT-system, and displaying how it may provide a transformative effect on the organization	This research scopes the social-science research field and identify where the discourse is taking place. It contributes to IS-research by highlighting a gap in the current social research and provides suggestions for additional areas of interest to the social-science research field

Table 5. Summary of research papers.

Paper 1: Using IoT – An early case-study

Mähler, V., & Westergren, U. H. (2018). Working with IoT – A Case Study Detailing Workplace Digitalization Through IoT System Adoption. In Proceedings of the IFIP International Internet of Things Conference (pp. 178-193). Springer, Cham.

This initial research paper focuses of the implementation of a pre-built IoT-system into a private organization, examining how it affected practices, structures as well as actors within an organizational eco-system. Attempting to understand both the challenges as well as the opportunities within the workplace when adding an IoT-system we decided on using the Technological Frames framework. The rationale behind using this framework was that it would allow for us to examine the effects on different actors and actor-groups along with their own respective understanding of the IoT-system. When examining how the actors understood the system and how different views might form, we argued that the Technological Frames framework was an ideal choice for this type of study.

The study examines views of three stakeholders as expressed by either single or multiple representatives. One was the organization, represented by the building manager, who coordinated efforts of maintaining a building (a large recreational facility) in terms of cleaning, rebuilding, and repairs. Users of the IoT system, who were hired externally by the building manager as custodians and maintenance workers formed a second set. The third stakeholder supplied both the hardware and software constituting the IoT-system and was contracted by the building manager to provide sanitary supplies. This third party initially only offered the supplies for large facilities, such as paper towels, toilet paper and soap, but now aimed to add their IoT system to their service portfolio and hoped to expand the organization in a direction that would allow them to enhance their value generation through a subscription-based model featuring this IoT system. The IoT system would detect shortages in supplies, then replacements would be ordered and sent to the recreational facility via the same company.

We examine how different actors and actor-groups reason about using the system – focusing on how it is understood by the various stakeholders. We further explore the eco-system in which the stakeholders act and how this eco-system has worked alongside the IoT-system to assist with issues that might arise. Using the TFR to analyze comments of both individuals and groups of respondents in interviews, and a presentation featuring all involved stakeholders, we explored the actors' perceptions and uses of the system. Conducting these interviews over a period of three months, with observations and meetings with the involved stakeholders and actors, enabled us to identify both challenges and opportunities recognized by each involved stakeholder.

The results show that the IoT system increased the building manager's expressed ability to monitor the work that was being performed, and to use the generated data in negotiations of future contracts based on performance. For the cleaners we found that they felt that it sped up their workflow and enabled them to be more proactive in their work. A challenge raised by the cleaners was that for some of them it had created additional stress about monitoring and anxiety regarding their performance. This was not considered to be a major issue by the other stakeholders and instead it was suggested to not think like that. Representatives of the third-party developer recognized opportunities to enhance and extend relationships with existing customers, forming new ways of conducting business, adding an additional product, and changing the value creation processes within their own organization. One of the identified challenges was a need for the cleaners to be open to the idea of a system such as this, and why it was being used.

In summary, Paper 1 highlighted the IoT system's capabilities to generate additional value for third-party developers, increase managers' capacities to make strategic decisions and users' capacities to improve extant processes. We reason that a congruence in the views regarding the IoT-system becomes pivotal for the implementation and that actors and actor-groups strove to coordinate amongst one another in order to achieve this congruence. Congruence in this sense was pertaining to the understanding of what IoT-systems can deliver, how value will be created and who this value will be created for. We further argue that incongruent views will hinder the progress and allow for greater uncertainty and a lesser incentive for adoption among the users – while a shared congruity helps to facilitate an easier implementation of IoT-systems.

Paper 2: The effect of beliefs, assumptions, and values

Mähler, V., & Westergren, U. H. (2019). Facilitating Organizational Adoption of Sensor-Based Systems: Espoused Beliefs, Shared Assumptions and Perceived Values. Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS-52) (pp. 6470-6479). HICSS.

In this paper we expand upon our previous research, comparing and contrasting the case presented in Paper 1 to that of a municipal project about to enter its implementation phase with a similar goal of creating an effective, optimized mode of custodial maintenance. This paper includes the stakeholders from Paper 1 and introduces an additional organization consisting of their own stakeholders. The new stakeholders were all connected to the municipality, including the Project Manager, the District Managers, the Team-Leader for the cleaners along with the cleaners themselves. The rationales and discussions of these stakeholders were examined through presentations and interviews, where it was contrasted towards the private organization in Paper 1.

Through the knowledge we gained from the initial paper and its suggestions for future research we chose to apply the lens of 'organizational culture theory' for this case study - examining the existing artifacts, espoused beliefs, and the basic underlying assumptions amongst the actors to explore potential differences amongst them. This framework was chosen to focus our examination more closely on structures within organizations that were implementing an IoT system, further exploring its facilitation when comparing two similar cases side-by-side.

We explore how the perception among managers and workers differ between the private organization examined in Paper 1 and the municipal project – and through this examination we identify additional factors that determine the susceptibility of adoption among individuals and teams. Through reanalysis of the previous interviews reported in Paper 1, and newly conducted interviews with actors, actor-groups, and stakeholders within the municipality we explore how an IoT system's value and purpose was described and understood within the organizations, along with the factors that determine the users' willingness to adopt it.

Through our analysis we learned that some key aspects differentiated the two endeavors. The results indicated that there was less initial negativity towards the system in the private organization than in the municipal project. In terms of the artifact, it was considered to be relatively good by the users in Paper 1, yet within the municipality there were less enthusiasm as the cleaners did not understand the need for money to be spent on an IoT system, when compared to other aspects of their daily work – where they felt that they could be better served by the money, such as free coffee for their break room or similar alterations. The same sentiment was often expressed in terms of their espoused beliefs regarding the rationale of the system. In one example the manager for the private organization describes how they use the collected data in negotiation with managers of the hired cleaning crew – yet the perception among the cleaners within the private organization was that they instead experienced less micro-managing while using the system than they had before. The cleaners instead stated that they do not have their customer looking over their shoulder in the same way as before, despite it having now been moved to a digital platform to examine performance.

Another espoused belief by both the Team-Leader as well as the District Manager at the municipality was that the Team-Leader did not fully understand the IoT-system and that the cleaners were not very tech-savvy. The purpose was viewed by cleaners as a potential way of decreasing the personnel, yet that was not a consideration that had been entertained by the Project Manager. And while the intention of the project was to generate material for future reference, the cleaners within the municipality suspected an ulterior motive behind the implementation.

One of the common underlying assumptions that became apparent through the analysis was the perceived low status of custodial maintenance. It had not been mentioned by the employees within Paper 1, yet it was discussed by both cleaners and managers within the municipality without being prompted, showing it to be an aspect which seemingly had not been considered before by the cleaners in Paper 1. From this study we identified three important aspects that differed between the private organization from the municipality and could be considered important facilitators of implementation of an IoT system. The first is a basic understanding of the system that is being used – along with its purpose, functionality, and limitations. We also detected differences in how the actors, especially the cleaners, viewed their own role and roles of others. The second important aspect, required to address these differences, is establishment of a shared view of the stakeholders' roles and responsibilities. In addition, to avoid potentially damaging speculation about motives among the different actor-groups our third identified important aspect is a strong, tangible vision for value creation.

Paper 3: Understanding the Digital Transformation in practice

Mähler, V., Westergren, U.H., & Jadaan, T.S. (2022). Digital Transformation in Practice: Organizational Implementation of the Internet of Things, under review in an international journal.

This paper continued the examination of the municipal project addressed in Paper 2 to illuminate the DT process and capture why firms embrace DT, as well as identify where organizational DT occurs, who is involved, and how conditions that foster successful DT are created. In the reported study we followed the involved actors over a period of two years. Deciding at an early stage to use the Practice Lens perspective a major aim was to understand IoT and its role as a digitally transformative technology. Another was to extend the research into both IoT implementation and Digital Transformation through a longitudinal study. The actors, actor-groups and stakeholders involved were all interviewed to gain a broad understanding of the effects and aspects that were changing as the users continued to use the IoT system. The interviews were spread over temporal phases called Initiation, Implementation (Early Stage), Implementation (Late Stage), and Evaluation. Most interviews were done primarily with the Project Manager, District Manager 2, and Team-Leader, as they all represented their own role as stakeholders for this project. The performed analysis using the Practice Lens perspective, showcase three fundamental aspects that we could see within the municipal organization during our study. These three aspects regarded the digital transformation of organizational practices, the usage of IoT as a digitally transformative technology, as well as the importance of formulating and maintaining a digital mindset.

We also identified ways that a DT can be affected by actions and behavior of the actors and actor-groups. These included lack of communication between managers and cleaners regarding the system's purpose, which was identified as a contributor to the cleaners' reluctance to accept it. The analysis was assisted by treating DT not only as an organizational-level phenomenon, but also as a situated action enacted over time by different stakeholders, in accordance with our framework. We found that when DT is studied as a micro-phenomenon, at the individual level, the scope of transformational action remains the same, but it may have profoundly different effects. In the organizational level perspective, the IoT system transformed the organization's identity as a provider of cleaning services, changing not only the practices but also the status of the cleaning profession. However, individual-level indications were also obtained (which were not initially evident) that this was accompanied by a transformation of individual cleaners' own professional identity and sense of self.

In this paper we also explored the IoT and its role as a digitally transformative technology, as the IoT system gradually came to become perceived and understood by the cleaners as an application on a tablet, whereas the Project Manager and District Manager instead focused more on the potential of an IoT-system such as this to gather data that could be subsequently used for optimization, cost savings, and performance monitoring. When comparing these differing conceptualizations of the system, we argued that they were strongly influenced by individuals' awareness of what the system was and what it could do.

We further showed that in contrast to other organizational IT, an IoT system is partially invisible to a human user, which may theoretically account for the paradoxical responses of the system's users (expressing dislike of managerial micro-management, while increasingly favoring an application that allowed more micro-management). This could similarly explain the paradox of managers stating explicitly that monitoring was not the intention for the system, while simultaneously gravitating towards solutions that included more monitoring. We further explored how changes in the digital mindsets began to appear among both the cleaners using it and managers responsible for implementing the system, which led to the project being deemed successful.

Our results show that IoT can fundamentally change organizational and individual perceptions of work practices, value creation, identity, and culture, creating opportunities for DT. Thus, to understand DT in practice, one must identify and consider different stakeholder perspectives, and to mitigate risk efforts should be made to increase system transparency, and proactive leadership can promote establishment of a growth mindset that is conducive to technological change.

Paper 4: What is being researched, what are we missing?

Mähler, V. (2019). The Thing About the Internet of Things: Scoping the Social Science Discourse in IoT Research. In IFIP International Internet of Things Conference (pp. 235-251). Springer, Cham.

In this paper I perform a scoping study to establish what extant research on IoT within the social science domain, thereby improving understanding of what the body of research is focusing on, along with aspects that warrant further research attention. Using Scopus as the reference database and focusing solely on journal papers published after 2014, I screened literature assigned to multiple subject-areas, including Social Science, Business, Management and Accounting, Psychology, and Arts and Humanities. Articles discussing the IoT or Internet of Things in the abstract and pertaining to the established subject areas were retrieved and checked. Finally, 1489 articles meeting the criteria were chosen, with a majority classified in the Social Sciences and Business, Management and Accounting subject-areas.

The total number of keywords within the dataset reached 8290, which were then categorized and sorted using VOSviewer based on the 25 most common ones. The sorted and categorized keywords produced were then labeled as clusters, showing the connection and interconnection among different keywords and what they pertained to. This allowed me to highlight themes within each cluster and through selective reading of the most cited articles within these clusters I could then thematize the emerging clusters as 'Organization', 'Logistics', 'Infrastructure', 'Technology', and 'Protection'.

The strongest theme in terms of citations and keywords was, unsurprisingly, "Technology", encompassing heavy discussion of Big Data along with the IoT. Weaker links, both within their own themes and connecting to other themes, were found for the 'Human', 'Privacy' and 'Education' keywords. They did not integrate very well with the themes they were assigned to, compared to other keywords assigned to the same themes. Basing the discussion on this finding, I suggest that in focusing and adhering to 'outlying' keywords, future contributions could be made to the social science discourse. I further argue that another cluster could be formed from articles with "Human", "Education", and "Privacy" keywords on the theme of 'Ethics' – an area of discourse that is not very prevalent despite the research being rooted in the social sciences.

It is argued that this becomes extra pertinent as sensor-based technology become more commonplace, and that the field of social science should be at the forefront of examining the types of social issues that can arise as such systems expand across entire logistic chains or cities.

Discussion

Before discussing the findings and presenting additional thoughts on results of the appended articles, I reiterate the overall research questions: *"How can IoT facilitate organizational digital transformation – and how can we further study and understand the effects of IoT capabilities on both the involved actors and organizational practices?"*

Each of the four papers have been used in order to address this question from different angles and using different frameworks – in order to explain how IoT systems may affect organizations, actors along with how value is generated and perceived. This discussion focuses on the outcome of these three aspects (Actors, Organization, and Value Creation) as they have been made visible through the performed studies. I further explain and theorize various effects of IoT systems, and how they can function as an enabling technology for digital transformation. Despite the division between actors, organizations, and value creation, they inevitably influence one another – and the separation should be seen as a way to describe the aspects rather than to delineate them from one another.

Actors in this context may refer to either individuals or groups of people that are involved in, or affected, in some way by an implemented system. An individual actor could, for instance, be a maintenance worker while the actor-group of 'maintenance workers' includes this individual actor and others. The actors may also be stakeholders in a project, depending on their role, and while an individual maintenance worker may not be considered a stakeholder, the actor-group of maintenance workers are. The purposes of this delineation are to facilitate discussion of how IoT system implementations can have effects on multiple levels within organizations and enable separation of individual actors from their groups, and their roles as stakeholders, in a focal project. Further, in this discussion *organizational practices, work processes* and *strategic aspects* are addressed. The term *organizational practices* encompasses how organizational actors perform their assignments within a work setting, including any physical or manual labor for the benefit of the organization employing them. It also includes their interactions with colleagues and other actors in their organization and/or other relevant organizations, their coordination and any relations or use of equipment involved in performance of their assigned tasks. The term *work processes* refers to hierarchical structures in the organization, and how work processes are thought and argued about by actors in order to create or enhance value within the organization. *Strategic aspects* are the micro-strategies enacted by groups or teams, and how they are enacted. These delimitations and definitions are intended to provide descriptive simplicity and are not intended to serve as any definitive description beyond the confines of this discussion.

IoT systems offer several capabilities and potential for change, which are further discussed in the following sections. Results of the underlying studies showcase these capabilities and potential for change, by describing how implementation of an IoT system can affect an organization by enabling or providing:

- Increases in capacity for real-time monitoring
- Ubiquitous cyber-physical applications
- Generation of context-aware data
- Generation of Big Data
- Potential for scalability

In the following sections I discuss IoT system implementation and how it may affect actors, organizations, and value creation. Finally, I present my own predictions for the future of IoT as a technology and theorization regarding its effects based on the underlying studies and generated data. I argue that when successfully implemented an IoT system can enable digital transformation of an organization, through redefinition of value creation, value generation, work processes, and organizational practices.

Actors – Using and being used by the IoT-system

The importance of the actors and their support during implementation of an IoT system was consistently apparent in all the studies. This applies not only to their use of the system, but also, as previously described by Orlikowski & Gash (1994), how they communicate and share their understanding amongst themselves and other stakeholders – *i.e.*, system congruence. As workers are ultimately the ones that are using (or being subjected to) the IoT-system in their daily work, they can help in facilitating the implementation, or hinder it. The role of the actor should therefore be considered paramount in the shaping and maintaining of organizational structures, also suggested by extant research (Schein, 2010).

Despite the importance of actors, Study 3, examining extant literature within the social-science field discovered that 'human' was one of the weakest links among IoT-research. Much of the focus is instead placed on how organizations can come to benefit from IoT-systems, with little detail on the benefits for the actors within.

This is similar to the results of Kutzner et al. (2018) examining DT literature and the apparent lack of end-user studies and longitudinal studies of the digital transformation phenomena. To categorize and discuss findings from the case studies, results concerning actors have been divided into those related to two concepts – changing of the processes and roles, and the importance of a shared understanding. However, this division is merely done for convenience as all of the aspects come to affect and are affected by each other.

Reshaping processes and coordination

The effects on the actors and actor groups when implementing the IoT system became visible as it was challenging and changing the preconceptions of how they viewed both their own roles and how it related to the changing of work processes. We could further observe that the perception of the actor's own role and the perceived status of the role would affect their level of suspicion towards the 'purpose' of the system, both internally within the actor group, and when speaking externally. The processes undertaken by the maintenance workers would change in regard to how they had originally planned and then executed their work. This was visible in terms of moving away from scheduling either on paper or a whiteboard - to now experiencing a need-based way of performing their work. This process change was viewed as a positive one in Study 1, where it was stated by some of the maintenance workers that they experienced more freedom in their work and not having the same pressure of quality assurance from their employer. However, this process change had also been described by some maintenance workers in Study 1 as increasing their stress – with some workers feeling like they were not accomplishing tasks as quickly as they should.

Research has shown how both the formulating and realizing of goals is vital to the social agency of a group (Pickering, 2001). Should the formulated goal among the cleaners from our studies consist of completing their assigned areas according to their schedule, and then being finished for the day or period, a need-based IoT-system may result in an adverse effect for the end-users. This is described by extant research as "*[...] coordination relies on the ability of interdependent parties to anticipate subsequent task related activity, that is, predictability* (Okhuysen & Bechky 2009, p. 491). The updating of new areas in need of cleaning can be seen as processes and tasks continuously become updated, which in turn makes the actors feel as if they are never truly 'done' with the work for the day and that they have little to no ability to anticipate the new tasks they will be assigned. How actors using an IoT system perceive its effect on them will also likely be influenced by personal factors and perceptions (Leonardi et al., 2012), but also reinforced or changed depending on the perceptions of their own social group, and work conditions (Pickering, 2001). These can be addressed, but they still remain a difficult set of structures to change depending on whether they are considered espoused beliefs or underlying assumptions (Schein, 2010).

The capacity to change or reinforce existing roles could be seen in both of the performed studies, where managerial actors and actor-groups progressively saw how the IoT-system had the potential to provide them with an advantage in the way that contracts were formulated and how work would be assigned or changed, which was a major change in terms of how they could benefit from generated data. However, the maintenance workers in Study 1 were positive towards the system despite it providing additional leverage to be transferred to the manager.

In the case addressed in Study 2 the same transfer of additional power was instead a point of friction. One of the respondents, for example, already considered their work to be too micro-managed, as described in Papers 2 and 3. Another major difference observed in the two case studies was in how the maintenance workers talked about their job. The workers who participated in Study 2 frequently referred to it as a low status job, a view that was shared and reinforced by the management. One of the interviewed cleaners expressed little trust in the rationale of spending money on a system for their benefit, when they were never considered for any other special treatment (Paper 2). This continued for some time in the early phase of the project addressed in Study 2, impacting not only the actors' initial willingness to use the system, but also their willingness to continue using it. For example, one of the cleaners quoted in Paper 3 claimed that they simply performed their maintenance task then reported it later in the IoT system because of the stress involved in doing it as they were working.

The hierarchical structures that both affect and are affected by the actors tie into the aspects of espoused beliefs and basic underlying assumptions as they are described in Paper 2. It was evident that the 'general knowledge' of cleaning as a low status job was an underlying assumption – where the IoT system was seen as a way of 'mitigating' this 'fact'. Inevitably meaning that the implementation of the IoT system to some degree reinforced the hierarchical structures in the organization and among actors. For the managers the system provided a new way of gathering information about the business processes and employees within the organization or teams – akin to the 'embedded panopticon' of monitoring which has been described by Jonsson (2006), regarding IoT systems.

This raises the dilemma for the managers of either disclosing the capability of the IoT system in its entirety to the actors, running the risk of the users not wanting to engage with the system, and thus jeopardizing the success of the DT, or not disclosing it and possibly infringing on the privacy of actors using the system. Another potential issue, if not properly addressed, is that digital technology like an IoT-system may adversely affect the areas within an organization that allows for coordination among different actors. This is a result of the structures, processes or organizational practices that were previously shared and understood suddenly experiencing a rapid change for everyone involved in the IoT-system implementation. This is because of the inherent aspects of the IoT-system that makes it such a powerful enabling technology for change – also becoming aspects of consideration unless properly handled. In exemplifying this, extant research describes how accountability among actors and stakeholders is required for successful coordination – namely that there exists a need in terms of data ownership as well as data gathering, predictability, and a common and shared understanding among users (Okhuysen & Bechky, 2010).

If an IoT-system is not correctly addressed, the coordination process becomes unclear in terms of data gathering, *i.e* ‘who owns the data and how it will be handled’ (Günther et al., 2017; Loebbecke & Picot, 2015; Newell & Marabelli, 2015), the predictability becomes unclear in terms of monitoring capabilities of the employees and process change based on how the technology is used (Jonsson, 2006; Karimi & Walter, 2015) and the common understanding among end-users and managers becomes unclear in terms of functionality and how the technology can be used along with the purpose that it serves (Orlikowski & Gash, 1994; Griffith, 1999). It also becomes visible how the actor-groups and individual actors play a major part in forming their own understanding and justifications behind the implementation. As it has been pointed out by extant research (Pickering, 2001; Leonardi et al., 2012), the social agency of the group is dependent on actors being able to enact goals in such a way that everyone can understand and visualize them – which was something that was more prominent in Study 1 than within Study 2. The actors’ perceptions of themselves and each other prior to the system’s implementation may strongly influence not only the success of the implementation of IoT or similar digital technologies, but also the processes undertaken by the actors in manners that make the extant roles, their relative status, and hierarchies even more pronounced.

Understanding the roles, the system, and the visibility

When talking about the understanding of the IoT-system it is not just in technical terms but in cognitive terms as well – which is similarly linked to the roles and processes previously described. How these shared understandings, congruence and incongruence has come to manifest is described below.

In both Study 1 and 2 it was elaborated by respondents that; if an actor that was using an IoT system perceived it as a threat towards the value of their own knowledge (in terms of processes or how work was intended to be performed), they were less likely to use it. In the Practice Lens perspective, Orlikowski (2000, p. 412) describes the importance of how technology is perceived, stating that: *“As people enact modified technologies-in-practice they also change the facilities, norms, and interpretive schemes used in their use of the technology [...] At the same time users’ knowledge of what technological properties are available to them may be updated or made obsolete, as with the meanings, expectations, associations, and conventions they attach to the technology and its use”.*

Manifestations of these understandings were detected and classified in Study 2 using the Organizational Culture framework by Schein (1988; 2010) in terms of the actors and stakeholders expressed ‘espoused beliefs’ and ‘shared underlying assumptions’, examining how these understandings came to affect them.

For the participating maintenance workers this included beliefs and assumptions not only regarding their job, but also regarding the associated rules and interactions of actors with different roles (in terms of either their own perceived treatment or actual treatment). Study 1 showed that a shared understanding of the IoT system among stakeholders would contribute to the success of the implementation, and this was recognized by the third-party system provider. As there was congruence in the actors' and stakeholders' understandings of the IoT systems technological capabilities and what it was intended for, there were little room for speculation among either of the parties.

Studies 1 and 2 also showed that an important aspect for the users of the IoT system was that their own knowledge was being considered (at least according to their perceptions), in the design or continuing functionality of the system. Moreover, the perception that their views were being heard in terms of functionality (expressed in both studies) appeared to promote willingness to use the system. In contrast, perceptions that their suggestions were not heard became tied to (and validated) the way they viewed their own work, as low status, and extant roles within the organization. This was described in Study 2 as a negative view, which also influenced their perceptions of the system.

Another important observed aspect, that I argue separates an IoT-system from other technologies, is how visible the technology is. This describes to what degree the actors know about the IoT systems ubiquity, and in what sense actors are aware that they are essentially using or providing an input for the system. This capacity regarding visibility was observable in both Studies 1 and 2, yet because of the ubiquity of the system, the notion of visibility and capacity for monitoring became more of a theoretical concept during interviews rather than one described verbatim by any of the actors involved with the IoT system.

Clarifying the aspect of visibility, the IoT system can be compared to a regular computer program. An actor working within an organization may be fully aware that their work computer is monitored against certain activities while browsing or using certain programs. To some degree this could be considered a negotiated understanding when provided with technology in an organizational or work-related setting, unless otherwise stated.

Contrastingly, an actor may be given a tablet device connected to an IoT-system of sensors, thinking that any monitoring is confined within the tablet, not realizing that their movements may now be tracked based on various sensor input from motion-sensors, tracked equipment or additional connected devices. This issue is something unique to IoT-systems and also unique in the way that it can affect the actors that are using an IoT-system or operating inside of one.

To contextualize this, an issue observed in Study 2 is that some of the users expressed an understanding of the way that the IoT system worked. While the respondents did not have complete understanding of the system initially, they later rationalized it as an application on a tablet rather than what it actually entailed. This was combined with the actors being unaware of the capabilities for monitoring, micro-management, and reduction in privacy in their work that the IoT system could offer. While an end-user of a computer software might still be unaware of any monitoring capabilities the software provided, it would remain limited within the realm of software and hardware. The observed difference with IoT systems is that this capability is no longer contained within the digital realm of a software package as the system becomes ubiquitous and cyber-physical (Borgia, 2014). It was further shown in both studies that this issue becomes less prominent when actors are aware of the IoT system's capabilities, understand how it functions and their own roles within it, and foster congruence regarding its capabilities. The effects of an IoT system on actors using it may therefore be related to their understanding of the system and their role within it, whether positive or negative. Jonsson (2006, p.191) describes an IoT system as an 'Embedded Panopticon' where: *"[...] visibility and non-visibility are of decisive importance concerning whether or not users can examine ethical dilemmas in computer use as visibility seems to be what triggers employees' feelings of being monitored or not"*. Detected monitoring issues includes suspicions of the system expressed by maintenance workers (Paper 3) and another describing the IoT system increasing worries about monitoring, that were not addressed, and instead being told that they should not think like that – which would arguably lead to further anxiety for the maintenance worker that brought the issue up in the first place (Paper 1).

In the study reported in Paper 3 we obtained clear indications of how shared knowledge among different teams, and understanding of the system, affected the 'digital mindset' of the workers. This refers to individuals' beliefs regarding the personal ability to learn about new systems or technologies, whether it has the capacity to change, the context of the change, and whether or not there will be winners and losers, or multiple parties could gain (Solberg et al., 2020). Introduction of a 'simplified' explanation of the system, as an app within a tablet, helped them to modify their digital mindset and view the system in a more favorable light. We also found that understanding and goals of the IoT system might differ significantly among both individual and groups of actors, depending on their roles within the IoT system, in terms of what would be considered 'acceptable levels' of monitoring, or the necessity of monitoring in the first place. Failing to properly address this issue or ignoring it outright will inevitably lead to actors misunderstanding the system or their role within. I argue that this could also prove to be be especially prominent with a ubiquitous and 'harder to understand'-technology like IoT, compared to 'regular' computer use.

Because of this, fostering a shared understanding of the system is increasingly important – and also challenging, if the system is less visible and therefore to some degree more abstract to actors that are either using it or operating within it, as previously described. Results of the studies indicate that in order to form a shared understanding among the actors' openness regarding the system and its capabilities is needed together with congruence between actors and actor-groups regarding a system's goals and purpose, and a supportive digital mindset among the workers using the system.

Organizations – Digital Transformation through IoT-systems

Study 3 showed that much of the literature surrounding IoT was in relation to creating organizational value, which is not surprising when researching a novel technology. Little is however mentioned in the literature regarding IoT systems and their digitally transformational capabilities as described by Vial (2019). This section therefore examines these aspects – observing the IoT-systems as enablers for Digital Transformation, on a micro-level of the organization within certain teams rather than on a macro-level of organizations as a whole.

The organizational change described within this section relates to the practical and 'direct' affects that IoT-implementation has in an organization. By looking at the change brought on by the IoT-system from both longitudinal and actor-centered perspectives, this also address the research gap regarding current digital transformation research where such research is necessary (Kutzner et al., 2018).

Changes in processes and practices

As the work processes are core aspects of any organization, they are inevitably important elements of organizational practices, and strongly influenced by a digital transformation. Thus, changes in the work processes and organizational practices associated with implementation of the IoT system noted in Studies 1 and 2 are described here.

In Papers 2 and 3 the process of how cleaning was to be performed was radically altered when compared to how the process had previously and 'traditionally' been performed. Changing the core process showed a profound effect on how the maintenance workers, were meant to carry out their tasks. The workers were in this case moving away from previously analogue methods of planning with paper-based schedules, whiteboards, and post-it notes - now changing to a novel way of work through the implementation of an IoT-system. This is also shown in extant research regarding DT, as the process of digital transformation not only affects the processes themselves, but also affects the organization at a socio-cultural level, making it increasingly important to gauge the function of each actor group, and how they may become affected (Hartl & Hess, 2017; Haffke et al 2017).

Günther et al. (2017) describe how the generation and exploitation of Big Data may necessitate alteration of organizational models for organizations to benefit from it. Accordingly, both Studies 1 and 2 showed that the IoT system allowed managers to acquire additional data regarding workers' performance, and also that it increased their capacities to monitor overall performance in real time and utilize the generated data when negotiating new contracts and prices. Thus, the changes in organizational practices were positive, overall, from the managerial perspective. In addition, although some maintenance workers who participated in Study 1 described the change in processes as increasing anxiety about being evaluated, their responses were generally positive.

When discussing the changes in processes brought on by the IoT system, one of the service provider representatives interviewed in Study 1 stated that the actors who were *least* in favor of using it were generally older and less tech-savvy than most. This is presumably related at least to some degree to the digital mindsets (Solberg et al., 2020) explored in Paper 3. However, we also observed that many of the issues noted in Paper 3 were raised by actors that would not fit descriptions as either old or not very tech-savvy.

Among the maintenance workers who participated in Study 2, both the focus group and interviewed actors (of various ages and technical skill levels) still described the IoT system as something that created an additional workload rather than optimizing the maintenance process, as they experienced it. Without reading too much into the comment of the service provider in Study 1, mentioned above, this still begs the question of whether such espoused beliefs or underlying assumptions may dissuade some actors from speaking up in the presence of both managers and any eventual service providers, for fear of being labeled out of touch, an aspect also described by Schein (2010). In the context of Study 1 the processes of facility maintenance had already changed as the IoT system was installed *before* the new team of maintenance workers had started their contract at the organization. This meant that the users were introduced to a new process at the start of their employment rather than being exposed to an ongoing change from a previous way of performing their tasks Some of the maintenance workers in Paper 3 did describe that their workload had decreased, but it was also described by other workers how they would have to spend their breaks filling in the information required by the IoT system, because they did not feel as if they had the time to do it while attending to their daily tasks. From a managerial perspective, and what was being communicated to the maintenance workers, the sole purpose of the system was to simplify the processes for those who were doing the work. While both projects were ultimately successful, Study 2 clearly showed that failure to create a shared understanding of an IoT system and/or handle any new issues arising from a lack of shared understanding, could potentially hinder its implementation and contribute to a general suspicion surrounding the system.

Understanding and mitigating this from an organizational standpoint means that there needs to be an overlap in how the goals are perceived and enacted to achieve the best possible outcome in terms of value generated (Saarikko et al., 2016), an overlap regarding what constitutes strategical success (Okhuysen & Bechky, 2010), and an overlap of formulating a business model, or business proposition - based on changing processes to account for changes that the IoT-implementation might lead to (Porter & Heppelman, 2014). Ultimately, if these changes in processes (in these cases of maintenance work) are scaled up even the business plan of an entire organization may need to change (Osterwalder et al., 2005). Such changes are indicative of the digital transformation of an organization and the accompanying shifts in processes that radically change the ways firms operate and leverage the value being created within these firms (Atzori et al, 2010; Baiyere et al., 2020). Moreover, while the case studies illustrate these effects on a small scale, they may provide indications of how processes are affected on much broader organizational scales, for instance in further tracking of supplies or monitoring of various kinds of cleaning or maintenance equipment, or even fleets of vehicles (and their drivers).

The investigated systems could also be used as elements in the creation of much, much larger IoT systems, with increases in the numbers of sensors to monitor multiple buildings or even cleaning districts within a city. It was reasoned by one of the managers that these types of systems could be used in order to monitor people that were living in assisted-living facilities or as a part of communal-living arrangements by improving tracking and the ability to respond to potential problems of people needing additional care. These were speculative future possibilities, suggested by the managers, but they also highlighted how the scalability of IoT-systems could conceivably be exploited to address broader municipal issues – and that they appeared to be less concerned about privacy issues. However, I would argue that from an organizational and strategizing standpoint it is important for organizations (especially those dealing with the public) to be careful in terms of monitoring capabilities. This is not only because of the reasons raised in the previous section regarding the effects on actors, but also because any perceived or actual breaches of personal integrity may severely damage trust in the organization

In the European context, this also has important implications related to regulations and rules regarding the collection and analysis of individuals' personal data. While monitoring capabilities have obvious advantages for strategizing, changes in laws regarding data protection may lead to needs to censor data enabling identification of individuals' characteristics, habits, or preferences. Much of it may even become illegal to collect, meaning that organizations need to be prepared to address such changes on a short notice if the data is being actively used by the organization.

Leveraging the capabilities and data

This section discusses the way that the managers in the focal organizations viewed the potential for leveraging the IoT system and its inherent capabilities and also presents further theorization regarding how changes in structures and strategies can affect organizations, based on results of the underlying studies.

In Paper 2, where we compared the initial organizational state (examined in Study 1) and the state of ongoing system implementation examined in Study 2, the two sets of participating actors and stakeholders revealed how both structures and the actors' perceptions of the structures differed. While their expressed views indicated that the desired outcome of the process was the same in both case studies, the hierarchical structures, and to some degree, the knowledge management differed, affecting actors' and stakeholders' perceptions. There were also differences in terms of how the managers approached the system – which was not surprising as the project addressed in Study 2 was more exploratory, while the focal IoT system in Study 1 was a ready-to-use product. The managers participating in Study 1 candidly stated that they viewed monitoring capabilities as useful for various reasons. In contrast, those participating in Study 2 were more hesitant to express any thoughts about monitoring aspects, and repeatedly described the system's implementation as something being done for the maintenance workers' benefit. Directly asking the maintenance workers if they knew that their work was being monitored would have been a breach of confidentiality in Study 1. However, the interviews with them indicated that they had greater understanding of the monitoring capabilities than this implied, and thus may have been at ease regarding the thought of being monitored.

This is in line with the argument by Jonsson (2006) regarding the visibility of an IoT system and its effect on actors' feelings of being monitoring. Due to the openness, the IoT system in Study 1 could have been more visible in terms of the workers' espoused beliefs and the underlying assumptions than the IoT-system in Study 2. An interesting observation in Study 2, addressed in Paper 3, was that as the project progressed, the managers also began to shift their focus more towards how the additional data could simplify the management of their teams, and applied to provide additional uses in terms of monitoring. This was potentially a result of the managers who participated in Study 2 starting to receive the generated data, with its inherent benefits of context awareness as described by Baesens et al. (2014), realizing the possibilities that it entailed for them. Despite expressing that the monitoring aspect would have benefits in terms of resource management, the managers were adamant that the purpose of the system was not to monitor anyone using the system. However, this would ultimately mean that managers were in complete control of the data, with the users not knowing which type of data that was being gathered or to which degree it was collected about them.

Similar to the monitoring capabilities, the capacity to improve management of resources in terms of both equipment and personnel was described initially in Study 2 as a secondary objective, or not intended. However, as the project continued, the capacity to improve utilization of resources was more prominently recognized and the Project Manager began to view it as increasingly lucrative. In addition, despite also stating that the IoT implementation would not lead to any job losses, the capacity to maintain the same quality with fewer maintenance workers was not a foreign concept either during the discussions. In terms of management, I argue that the change pertaining to the managers own mindset should not be considered a 'slip up' or 'saying the quiet part out loud'. I instead argue that it is an expected progression, as it became more evident how managers could utilize the gathered data, changing the way that they organization operated, an aspect already described within extant research considering IoT-systems (Günther et al., 2017; Rai & Tang, 2014).

Despite decisions to utilize (or refrain from using) data, remaining open about what the system entails and may be used for remains imperative as it will also affect how workers perceive the visibility of the system and the sense of being monitored (Jonsson, 2006). Moreover, as previously mentioned, the monitoring may also raise regulatory issues regarding how information may be gathered and used. While those are issues that may be better left to someone with legal training, lack of a shared understanding of a system's capabilities could clearly lead to unforeseen consequences when efforts are made to exploit them. As the managers may share their own goals and perceived paths towards them, they also must also ensure that these goals are shared, or at least understood, by the team members to avoid system incongruence, as described by Orlikowski & Gash (1994) and foster willingness of all the actors to facilitate a digital transformation within an organization (Haffke et al., 2016).

The importance of a shared understanding of the IoT system and appropriate handling by the managers of its transformational capacity to foster such understanding was clearly apparent during both case studies. To harness the capacity to alter how business is conducted and perceptions of the business logic, managers face the additional tasks of redefining how the actors using the technology should approach their own work logic, while potentially also struggling with their own (Osterwalder et al., 2005; Vial, 2019).

This is also connected to how the extant structures within the organization are formulated, how change is communicated, and the congruence of actors' views pertaining to expected outcomes and potential. All these aspects show that the implementation of an IoT system may foster major changes in organizational capabilities, and hence business logics.

Value Creation through IoT – What value and for whom

How value is created and reconceptualized through use of an IoT system will depend on many factors, as exemplified in the preceding sections. This section outlines and discusses aspects of value creation that emerged in the examined cases, then provides a more general discussion based on the results regarding these aspects when either examining or trying to facilitate implementation of IoT systems.

In Study 3, value creation aspects of IoT systems permeated every theme in the studies identified in the literature search, so it was clearly regarded as important by social scientists addressing them. The articles considered in Paper 4 provide excellent insights into the various fields where the IoT can generate additional value, and hence the value creation for stakeholders observed in our studies.

Realizing value for different stakeholders

The concept of increased value creation can be considered at the heart of what constitutes a digital transformation. Because of this it is also a relatively abstract concept as the obvious question would be *'value for whom?'*. Throughout our case studies there was clear evidence that the IoT system implementation necessitated collaboration with third-party firms to strengthen and allow establishment of new value networks along with the formulation of platform ecosystems (Westergren & Holmström, 2012; Skog, 2020). What could be seen as unique in terms of the value generated was that it was a tangible and profound effect on all stakeholders, irrespective of role. The potential for additional value was visible in terms of how processes could be changed and simplified for the maintenance workers, how the data could be leveraged by the managers or how a third party could be entirely responsible of the system (as in Study 1) or only involved in the development and design of the system (as in Study 2). The value that could be generated also comes with the caveat of requiring changes in the ways that the business or organization normally conducts work, which is indicative of a DT (Vial, 2019). As IoT systems create avenues for resource management and work process optimization, the value created must also be contrasted with potential effects on both the organization and the actors within it. If the value for different stakeholders varies it can be further argued that value will depend on how involved parties perceive value and the purpose of the transformation. This relates to the previous discussions in terms of management of processes and the need for a shared understanding among stakeholders. This necessity in terms of knowing which person that is responsible for what aspect of the work, which is also presented by Okhuysen & Bechky (2010), as a key aspect of coordination - where accountability by different independent parties is of major importance when attempting to successfully facilitate a greater degree of coordination among the actors within the organization.

When considering the generated value, and value for whom, it is important to address the extant structures, as illustrated by the skepticism exhibited by the maintenance workers in Study 2. Moreover, as organizational culture can affect and be affected by extant structures (Schein, 2010), I argue that implementation of an IoT system could create or reinforce existing *negative* structures, depending on how it is handled. This was apparent in Study 2 as some participating users did not feel that they understood or trusted the system enough to base their work around it, and similarly while it was intended to simplify work it gave them additional work, in the expressed need to enter additional information into the system during their breaks instead of when it was done. This shows that while the IoT-system did change the way that work was being performed, it still requires continuous work to make sure that the changes in processes can create value for all involved parties, also described by extant research regarding IoT systems (Pflaum & Gölzer, 2018; Haffke, et al., 2016).

One of the aspects that both the building manager in Study 1 and Project Manager in Study 2 agreed was that they wanted to retain ownership of the data being generated. It could therefore stand to reason that both of the managers saw the potential value in the data, and that by keeping it away from third parties it might serve to either let them have a greater autonomy in terms of interpretation or any future unrealized value retained within the data – similar to what has also been argued by Zaslavsky et al. (2013) regarding the control of data. For managers, the immediate value that could be generated with the limited amount of data in these studies revolved around the value they could see for their own organization. A more cynical researcher might hypothesize that one of the reasons for this was that the managers did *not* want a third party to be able to monitor how everyday work was done in 'their' workplace.

In the more literal sense of value creation, we could observe more pronounced aspects of value generated regarding strategizing, changed processes, as well as increased efficiency. In our Studies 1 and 2 we have observed how IoT-systems generate value to the organization and work to facilitate a digital transformation through additional collaborations, increased process efficiency, a greater ability to manage resources, and new ways in which one or more organizations can expand on reshape their extant strategy or business logic. And while these are examples generated from two case studies, there are undoubtedly additional areas of exploration in terms of where value through IoT-system implementation may be either added or reconceptualized. I argue that IoT-systems may act as an enabling technology for digital transformation, but that in order to capture and realize this into more than just a conceptual value, the previously described aspects of the implementation must be accounted for. Similar to the necessity of a shared understanding of the system among actors, the stakeholders must also ask themselves where and how they see that value may be created, and for whom.

The unknown future of IoT

Based on the studies and the presented discussion above, one of the main aspects of an IoT-system is that there is no one single 'part' of the IoT-system that makes it digitally transformational. The capability for enabling digital transformation instead resides in the amalgamation of effects and capabilities described in the chapters above, and at the start of the discussion. Implementing any type of system will to some degree inevitably change aspects such as processes or require the participation of the actors, instead I argue that it is when *all* aspects of the organization are affected that one may view the change as being a digitally transformative one. Within this dissertation and case studies we have seen the effects of two IoT-systems on two different sets of actors and organizations, along with how a change in how value is generated and conceptualized by both the involved organizations and the actors within. Study 3 showcased that while organizational aspects and value creation both remain important areas of study for the social-science field regarding IoT-systems, the roles of actors inside of the organizations, or as the beneficiaries of the change, is not as explored.

Because of the gap in the research regarding IoT-systems and the effect on actors, alongside with the theorized socio-cultural aspect of DT (Haffke et al 2017; Gong & Ribiere, 2021; Hartl & Hess, 2017), my argument becomes that: If IS research aims to portray digitally transformative changes – either in and of themselves or as changes enabled by IoT systems, the effects on both actors and organizational cultures involved in an IoT system's implementation should be considered an important a concept as the more visible organizational and value transforming changes. This requires both researchers and practitioners to become further involved and to attend to the thoughts and reasonings of actors that are involved in IoT system's implementation, which can be achieved either through interviews similar to the ones performed within our studies, or in a more informal setting of observing how the changes actually affect the work.

Through such observations, actors may realize aspects that they like or dislike as they are performing their everyday work routines. I reason that one challenge that might arise for practitioners attempting to question actors who are 'subjected' to an IoT system is that they may be perceived as extensions of the administrator or manager of the system, thus prompting less truthful or direct answers.

For instance, if I had been conducting interviews as one of the managers, truthful answers like the ones in Study 2 regarding the maintenance workers never getting anything simply for their benefit, might be omitted by the respondent – either on account of politeness or fear of reprisals. However, this is of course my own theorization, as it was also clear that the maintenance workers had previously raised complaints about similar aspects to the managers, but not feeling that they had been heard or that these issues had been sufficiently addressed.

Like the title of this chapter suggests, the issues surrounding value creation will be contingent on the ways in which managers or administrators utilize the IoT-system and if the value creation is intended to improve the outcome for all or just a handful of actors. This is connected to suggestions derived from Study 3 that the addition of 'Ethics' as a research theme would not only fill a gap in extant literature but also prompt examination of aspects that I argue are particularly relevant to social science. I further argue that this is especially true when addressing technology or policies that offer even the slightest risk of encroaching on individual freedoms. Observations in our studies, together with the review of extant research, indicate that ethical issues that can arise with IoT systems or similar digital technologies extend far beyond monitoring capabilities within an organization. Additional aspects to consider include the visibility of the system (Jonsson, 2006), and leverage of data generated by the system (Günther et al., 2017). The problematic aspects of visibility, monitoring, and data generation are exacerbated by IoT systems' capacity for scalability by simply adding more sensors and storage space (Ohlhorst, 2012). In theory there is no upper limit to the number of sensors that may be connected within a system, so long as the processing power and storage capacity can also be scaled.

To illustrate why this may become an issue let us broaden the scope, from IoT systems within organizations, to IoT systems covering 'smart' cities, where multiple buildings or entire blocks may be fitted with sensors (Hashem et al., 2016). If an entire city were to be covered in sensors both the monitoring capabilities and levels of data generation would be staggering. In combination with the extended context of data and meta-data generated by the sensors of an IoT system (Zaslavsky et al., 2013) a large enough IoT system would enable the tracking and analysis of entire groups of people operating inside the system. Machine-learning algorithms capable of far outperforming any human analysis could then be used to find, and extrapolate, meaning in the massive datasets. Value could lie in spotting emerging trends (such as protests forming) or predictive patterns among individuals and groups based on the sheer volume of data and examples available for analysis. This is (currently) unheard of, yet still within the realm of possibility as technologies such as facial recognition already exists on a large scale. While I concede that an adherence to 'actors' and 'ethical aspects' may be a tall order for any hypothetical autocratic regime using IoT-systems to monitor people, the more reasonable context of organizations can still benefit from a greater insight and understanding of ethical aspects surrounding IoT-implementation. Such insights would allow for researchers and practitioners to better realize how a seemingly well-meaning plan for added monitoring may lead to unintended or unethical consequences. Failure of researchers to attend to these aspects may also inadvertently lead to reductions in the data available for informing future policy-making regarding IoT systems or similar ubiquitous digital technologies.

Taking a step back from the ethical aspect and general discussion, and returning to the empirical observations of the studies, I conclude this discussion by reiterating why I have come to argue that the Internet of Things functions as an enabling technology for Digital Transformation. The definition used to describe digital transformation within this dissertation is that by Vial (2019), where it is argued that a digital transformation can be considered as a process where disruptions are created by digital technologies (which in this case is the IoT-system). The digital transformation further triggers a strategic response from organizations that are aiming to change how value creation is being realized within said organization. This process is one that is done simultaneously as the organizations also manage the structural changes, and organizational barriers that also influence the success of the process.

I argue that all of these criteria have been shown in terms of the generated results and the following discussion. Among the actors it has been visible that the IoT-system has come to challenge an organizational culture as shown in Papers 2 and 3. The studies has further shown how the extant culture has also played a part in the openness among the actors that has been using the system – and suggested for ways to mitigate negative aspects and suggesting positive actions in terms of enhancing value creation. The strategical response has been observed among all the actors in both Study 1 and 2 within two separate organizations where the IoT-system came to change the way that contracts were being negotiated, work was being monitored, and processes changing for the actors that were using the system. Studying this transformative process over time, the IoT-system has remained a central aspect, and despite the relative low number of sensors within each of the system the digitally transformational change has still been observable in multiple stages of the process using three different theoretical frameworks. Combining the generated understanding when using all of these frameworks, it allows for clearer picture of how an IoT-system may act as an enabling technology when attempting to digitally transform parts or the entirety of an organization.

As both the strategies undertaken, along with the organizational aspects that have been examined are done so on a micro-level, a natural question would then be if this change would translate if applied to a macro-level perspective of digitally transforming the entirety of the organization. Based on the results from the case-studies, and findings of extant literature, I argue that it would make little difference in terms of presented opportunities and challenges. The actors within each of the changing departments will not be any less affected simply because everyone else is, and similarly the organization itself is highly likely to be interested in ways to generate value through any new system. For this reason, the Internet of Things, and the way that it can enable for Digital Transformation remain a broad and expanding field, where much knowledge can still be gained by both practitioners and academics.

Concluding remarks

This chapter outlines the conclusions from Studies 1, 2 and 3 and their subsequent discussion in this dissertation. It also provides the reader with indications of additional aspects that warrant future investigation to enhance understanding of both the Internet of Things and Digital Transformation.

Conclusions and Contributions

In conclusion, this dissertation has shown how the IoT, and associated systems can affect organizations that implement them in terms of three aspects – the actors, organizational practices, and value creation.

For the actors, the results show that performed practices may profoundly change, that different actors may have differing perceptions of monitoring aspects, and the importance of all actors having a shared understanding of the IoT system and its capabilities throughout its development and implementation.

Regarding organizational practices, it has been shown that an IoT system can affect the existing structures within an organization, by either radically changing or reinforcing them. It has also been shown that even in organizations that may not yet utilize the data generated by an IoT system it is regarded as having innate value that is important to the administrators or managers of the system in terms of further use.

Regarding value creation, it has been shown that the value that is either generated or reshaped by the system's implementation can be easily quantified in terms such as use of the generated data to negotiate contracts, and monitoring the timing and efficacy of processes, employees, and equipment.

It has been hypothesized that the scalability and monitoring capabilities of IoT systems can infringe on personal privacy, which makes the visibility and shared understanding of an IoT system important for future development and research, for both practitioners and academics. It has also been shown that IoT systems have the potential to simultaneously change aspects of actors, organizations, and value creation, in accordance with findings of previous studies of the digital transformation of organizations.

Based on these results I argue that IoT systems have the technological capacity to enable digital transformation and have tangible effects on both how organizations perceive value and strategize to achieve it.

The studies and results also provide insights regarding actualized changes in organizations, actors, and value creation resulting from an IoT system's implementation, in addition to theoretical changes, and show how the selected frameworks can be used to improve understanding of IoT systems and their surrounding environments.

The studies also contribute to extant digital transformation research and serves as a response to the call for more case and longitudinal studies, which has been expressed in previous research. Moreover, the dissertation contributes to research on social science-related human and ethical aspects of IoT systems, and Study 3 showed that these aspects require further research.

Suggestions for future research

Future researchers should consider examining IoT implementation based on the conclusions in this dissertation regarding actors, organizations, and value creation to explore their generality, or if there are important setting-dependent variations. This should be done partly because relatively little technology is generally involved in maintenance workers' tasks, which may have influenced the observed impacts. Further suggestions derived from Study 3 are that academics rooted in both IS and social sciences disciplines should both extend their studies to address neglected socio-cultural aspects of the Internet of Things and digital transformation and assess trends in their respective fields.

Another strong suggestion concerns ethical aspects and how to address policymaking regarding ubiquitous technology such as IoT systems and the Big Data that large IoT systems can potentially generate. This will become increasingly important as areas of usage of sensor-based systems continue to grow alongside the processing power available to consumers. Research into these aspects could ensure that lawmakers and politicians have the information needed to make educated decisions. Additionally, more case-studies regarding both IoT systems and digital transformation are needed to explore any additional effects that might become prominent, and longitudinal studies to detect shifts and patterns that become gradually apparent.

DT researchers should also explore if the capability of IoT systems to enable DT is unique to this kind of system or if the results presented in this dissertation are also applicable to other types of technologies, such as cloud-based computing, social media or other types of technology that might also be considered to be ubiquitous in a similar fashion to IoT systems.

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