Digitalizing interorganizational relationships

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Abstract

In this doctoral dissertation, I explore how the use of relationship-specific digital trace data for the optimization of interorganizational processes affects collaborative dynamics. In a multiple case study of seven interorganizational relationships, I show how digital real-time data technologies at interfirm boundaries create operational transparency. This transparency facilitates the coordination and control of increasingly complex digitally mediated interorganizational tasks. Through three essays, I contribute to strategic management and organization theory. First, I describe how digital real-time data technologies ease interorganizational coordination and control. I then theorize broader effects on the structures and dynamics of collaborative relationships.

In the first essay, I situate the empirical phenomenon of interorganizational big data technologies theoretically within the academic discourse by conceptualizing technological embeddedness as a characteristic of interfirm relationships. I argue that greater technological embeddedness augments collaboration processes through richer data flows, which enable better coordination and control between partners. A digital organizational infrastructure, technological embeddedness is a precondition for the observations I discuss in my two empirical essays.

In the second essay, I empirically analyze how organizations can use interorganizational big data technologies to manage collaborative tensions. I find that these technologies create what I term orthodox spaces, a data-based organizational design that leverages managers' data-driven mindset and technologically embeds specific interorganizational processes. This channels managers' attention to a subset of collaborative goals and thereby suspends tensions at the process level.

In the third essay, I empirically explore how the varying types of operational transparency that the introduction of interorganizational big data technologies brings affect the development of interorganizational trust. I find that these technologies leverage managers' attitude for transparency, which privileges trust in numbers over trust in relationships. Organizations use technology-induced transparency initially as coordinative control, but over time start using it as monitoring control, thus modifying the composition and development of interorganizational trust.

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Contents

PART 2

List of Essays

1. Katharina Cepa and Henri Schildt (2019), "Technological Embeddedness of Inter-organizational Collaboration Processes", Sydow, J. and Berends, H. (Ed.) *Managing Inter-organizational Collaborations: Process Views (Research in the Sociology of Organizations, Vol. 64)*, Emerald Publishing Limited, pp. 91-115. https://doi.org/10.1108/S0733-558X20190000064007

2. Katharina Cepa and Henri Schildt (unpublished essay). Engineering collaboration with digital data: How orthodox spaces suspend interorganizational tensions.

3. Katharina Cepa (unpublished essay). Transparency technologies and interorganizational trust – How observers use transparency to coordinate and monitor partners.

PART 1

Introduction

1. Introduction

Interorganizational relationships can provide learning, access to resources, efficiency, and legitimacy to partnering organizations (Oliver 1990), offering a source of value creation and competitive advantage (Dyer and Singh 1998, Lavie 2006, Powell et al. 1996). As organizations establish collaboration, they set the scope of cooperation – the goals and partner inputs – and design coordination processes to achieve the agreed-upon goals (Gulati et al. 2012). Cooperation advances episodically through cycles of learning and adjustments based on the insights from ongoing exchange of information and knowledge in daily operational coordination processes (Doz 1996, Ring and Van de Ven 1994). Much of this information and knowledge exchange occurs through interorganizational information systems (Im and Rai 2008, 2013). Consequently, interorganizational relationships are often entwined with the information technologies that support and mediate their collaboration (Argyres 1999, Baker and Hubbard 2004, Hitt 1999, Lee and Berente 2012).

Recent advances in information and communications technology enable greater connectivity and information-processing power at increasingly low costs. These technologies enable the exchange and analysis of what is commonly referred to as "big data," voluminous and varied process-specific data in real time (Chen et al. 2012, Yin and Kaynak 2015). Given their greater information-capturing, processing, and storing capacities, these technologies promise the creation of value in organizational and interorganizational contexts. In the pursuit of greater operational efficiency, organizations increasingly make use of this development and introduce new technology-based processes to optimize complex organizational and interorganizational operations (Kagermann et al. 2013, Lee 2017).

Within the scope of interorganizational relationships, one type of big data – digital real-time sensor data – is of particular interest. Digital real-time sensor data chronicle the use patterns of industrial equipment employed in the production of industrial goods and services. Such chronicling creates "digital traces" (Lazer and Radford 2017) and renders (inter)organizational processes visible and evaluable (Zuboff 1988). Where they are applied to interorganizational processes, digitalized tasks go beyond supply chain optimization (an area that has long been subject to optimization via information technology) and extend to increasingly interdependent tasks that were previously difficult to coordinate with external partners. Examples of such interorganizational operational processes are predictive

maintenance, consulting services focused on optimizing industrial equipment usage, or in-depth analyses of industrial equipment and service performance based on the collection, transfer, and analysis of big data. In these processes,

collaborating organizations are now able to coordinate their tasks around concrete interorganizational processes because, as big data technologies mediate collaboration across organizational boundaries, they provide codified representations of complex interorganizational processes (Bailey et al. 2012, Jonsson et al. 2018). Organizations then analyze these "digital traces" (Lazer and Radford 2017) to identify ways to optimize equipment maintenance and usage for efficiency gains or to assess equipment and service quality more precisely. Greater connectivity levels and digital mediation allow subsequent remote process adjustments. This provides organizations a high level of technology-induced transparency of their internal and interorganizational processes, as well as a wealth of opportunities to digitally coordinate and control increasingly complex partner interactions.

As organizations introduce big data technologies to their interorganizational boundaries, these collaborative relationships are likely to evolve. Yet, we know little about this technology-induced transparency and how the new coordination and control affordances (Leonardi 2011) of digital mediation affect interorganizational relationships and their management. While these technologies may appear to be just another new wave of technology, there are indications that the ubiquity of digital real-time data and associated digital infrastructures (Tilson et al. 2010) could have substantial effects on how we regard and manage organizations and their relationships (Brynjolfsson and McAfee 2014, Lyytinen et al. 2016). For instance, in many respects, interorganizational big data technologies could act as extensions of Enterprise Resource Planning (ERP) systems or online marketplaces, simply making interorganizational governance even more efficient and effective (Aral et al. 2018, Baker and Hubbard 2004, Malone et al. 1987), however there is growing empirical and theoretical support that interorganizational big data technologies extend beyond optimized governance. In particular, the considerably higher connectivity and information-processing abilities of big data technologies can affect internal organization and the management of long-term collaborative relationships (Brynjolfsson and McAfee 2014, Günther et al. 2017, Kagermann et al. 2013, McAfee and Brynjolfsson 2012). The majority of this knowledge base describes how big data technologies help improve concrete business processes and operational tasks, leaving unexplored how such operational-level changes affect the long-term management of collaborative relationships in digitally enhanced environments.

1.1 Research questions

To explore how and through which mechanisms interorganizational big data technologies shape collaborative relationships, I address the following research question: *How does the introduction and use of interorganizational big data technologies affect interorganizational relationships and their management?* This is a wide-ranging question with multiple possible answers, therefore I approach it by asking three sub-questions that I address in three separate essays.

In the first instance, I was concerned with the structures interorganizational big data technologies create and their effect on managing collaborative relationships. For this, I considered interorganizational big data technologies in terms of what they afford partnering organizations: They allow the creation, exchange, and analysis of digital real-time data. Such data are voluminous, timely, varied, and complex (Jin et al. 2015, Lee 2017), allowing organizations to create detailed transparency over specific interorganizational tasks and processes (Jonsson et al. 2018) and to manipulate these processes digitally in real time (Bailey et al. 2012). This increases information processing between partners and, thus, allows collaboration on increasingly complex tasks. Yet, the literature currently does not capture such data-based structures systematically, even though there are clear benefits for such conceptualization. Thus, to conceptualize these data-based structures and situate the empirical phenomenon of interorganizational big data technologies within the scholarly discussion, I ask my first sub-question:

> *RQ1: How does the interorganizational capture, creation, and exchange of digital real-time data and "big data" affect collaboration processes?*

To situate the empirical phenomenon of "interorganizational big data technologies" theoretically within the academic discourse, it is important to define what they are and what they do in organizations. This allows me to establish what sets interorganizational big data technologies apart from other technologies that facilitate interorganizational collaboration. "Traditional" interorganizational information systems facilitate the effective exchange of knowledge (Im and Rai 2008, 2013) and allow more efficient (Aral et al. 2018, Baker and Hubbard 2004) and complex collaboration patterns (Boland et al. 2007, Lee and Berente 2012). Yet, interorganizational big data technologies' affordances might lie beyond those of traditional information systems. Big data technologies allow the efficient exchange of complex, varied, and voluminous real-time data (Chen et al. 2012, Jin et al. 2015, Lee 2017),

which might present affordances that lie beyond "small data" interorganizational information systems (Brynjolfsson and McAfee 2014, Constantiou and Kallinikos 2015, Schildt 2017).

| RQ 1: |
| How does the interorganizational capture, creation, and exchange of digital real-time data and "big data" affect collaboration processes? |

Data-based interorganizational design:
Effects on mutual adaptation and temporal structuring

Technology-induced transparency:
Effects on the development of interorganizational trust

| RQ 2: |
| How do real-time digital data flows structure and shape internal tensions in interorganizational collaboration? |

| RQ 3: |
| How does technology-induced operational transparency affect the development of interorganizational trust? |

Figure 1: How the three research questions build on each other

Interorganizational big data technologies facilitate real-time digital flows between partnering organizations. As pointed out above, organizations analyze these data flows to create virtual representations of specific interorganizational processes and to potentially manipulate them to adjust these represented processes (Bailey et al. 2012, Boland et al. 2007, Jonsson et al. 2018). Such technological embedding of interorganizational collaboration processes into digital infrastructures has been shown to reduce transaction costs (Aral et al. 2018, Baker and Hubbard 2004, Chen and Kamal 2016). Yet, considerably less scholarly attention has been paid to how such interorganizational data-based designs affect the management of collaborative tensions.

Collaborative tensions appear as managers attempt to satisfy the inherently opposite needs of alliances (Putnam et al. 2016, Schad et al. 2016). Organizations pursue simultaneously the needs of trust and control, information sharing and protecting, or short- and long-term objectives in alliances (Das and Teng 2000, Jarvenpaa and Majchrzak 2016, de Rond and Bouchikhi 2004). At any given point in time, an organization in an alliance cannot simultaneously pursue all needs, as each need serves a different goal on a different timescale. Therefore, there is a range of different strategies to deal with these tensions, ranging from separation (Brattström and Richtnér 2014, Klarner and Raisch 2013) to integration (Perkmann et al. 2019, Smith and Besharov 2019, Zimmermann et al. 2015). Digitally enhanced

12

environments, namely the modularized, containable, and automatable exchange and processing of vast amounts of complex digital real-time data, might provide new opportunities to manage these tensions. My second research question therefore asks:

> *RQ2: How do real-time digital data flows structure and shape internal tensions in interorganizational collaboration?*

Interorganizational big data technologies can create varying degrees of technology-induced transparency and digital mediation, with a range of potential implications for collaborative relationships and their management. The interorganizational creation and exchange of digital real-time data and "big data" provides detailed representations of specific interorganizational tasks and processes. Such representations often take the form of precise metrics that organizations can use to coordinate and/or monitor collaboration with their partners. In this way, technology-induced transparency provides a new form of control. Controls are tied closely to interorganizational trust (Brattström and Richtnér 2014, Lumineau 2017, Vélez et al. 2008), so that an increase in easily accessible affordable controls may affect the development of such trust.

Yet, we do not know whether technology-induced transparency as coordinative control increases interorganizational trust, whether it is used mostly as monitoring control and thereby reduces such trust (Vélez et al. 2008), or how trust develops as technology-induced transparency is used simultaneously for coordination and monitoring. Therefore, my third sub-question explores how and through which mechanisms different types of technology-induced transparency affect the development of interorganizational trust:

> *RQ 3: How does technology-induced operational transparency affect the development of interorganizational trust?*

These research questions have great significance for management practice. Organizations increasingly offer and implement interorganizational big data and advanced analytics applications in the pursuit of greater efficiency and better coordination of specialist services (Kagermann et al. 2013), yet there are many potential obstacles to achieving these goals. Managers currently do not have much information or use cases available to decide whether or how to implement interorganizational big data technologies. Most available material stems from white papers and use cases published by the providers of such technologies. While this material provides comprehensive technical explanations of the technologies and their operational value to prospective customers, they often fail to address

potential implications for the broader management of relationships. Such a technical foundation is highly relevant to making investment and implementation decisions, but on its own not very objective or complete. Moreover, as these technologies are new, the technology providers' insight into how such operational efficiency technologies affect the more complex issues of managing long-term collaborative business relationships is limited. The above research questions aim to fill this void by providing a scientific and independent account of the implications that go beyond the technical details of the technology or its use. Practitioners need a reliable, independent source for making informed choices about technology adoption – something this dissertation aims to provide.

1.2 Structure of the thesis

This dissertation is essay-based and consists of two parts. In Part 1, I situate the phenomenon of interorganizational big data technologies within strategic management and organization theory and motivate my research questions. I further describe my methodology, summarize my findings, and discuss my contribution to theory and practice. In Part 2, I present the three essays that make up this dissertation.

In Part 1, I first define the empirical phenomenon and formulate my research questions in light of strategic management and organization theories. For this, I bring together literature on interorganizational relationships, big data (and comparable) technologies, and the use of (advanced) analytics in organizations to provide a backdrop to this dissertation and motivate my research questions. I then describe the methodology I adopted to address these research questions, before presenting summaries of my findings and discussing my contributions to theory and practice. To conclude, I reflect on limitations of this dissertation and formulate avenues for future research.

In Part 2, I present my three essays: one conceptual and two empirical pieces. The conceptual essay has been accepted for publication in a volume on interorganizational collaboration processes in the edited book series "Research in the Sociology of Organizations." The two empirical essays are unpublished manuscripts.

2. Theoretical background

Here, I will outline the theoretical background to my dissertation. I start by defining interorganizational relationships as comprising two interrelated aspects: cooperation and coordination. Cooperation is the strategic-level agreement on joint goals and the alignment of partner interests, and coordination is the operational division, linkage, and synchronization of actions to achieve these goals (Gulati et al. 2012). Concentrating on the coordination aspect of collaboration processes, I will discuss two types of activities to facilitate coordination: First, harmonization as the mere practical orchestration of dispersed interorganizational tasks to improve their effectiveness and, second, control as coercive orchestration of these interorganizational tasks with the aim to further an organization's goals. Moving on, I discuss how information technology – in particular the new wave of digital real-time technologies often subsumed under the label "big data technologies" – affect collaboration processes. For this, I conceptualize "technology-induced transparency" as characteristic of digital real-time technologies to show how these technologies might affect both cooperation and coordination in interorganizational collaboration processes. I conclude this section by discussing how organizations can use interorganizational big data technologies as harmonization and control tools, and how such uses facilitate the efficient spanning of interorganizational power, efficiency, and knowledge boundaries.

2.1 Interorganizational relationships

Interorganizational collaboration processes are "relatively enduring transactions, flows, and linkages" between two or more organizations (Oliver 1990, p. 241), which rely on neither market nor hierarchical mechanisms of control (Hardy et al. 2003, p. 323). Collaborative, long-term interorganizational relationships comprise cooperation and coordination processes, where the former is concerned with managing the relational risks and the latter addresses the operational risks in governance (Gulati et al. 2012). Cooperation is the "joint pursuit of agreed-on goal(s) in a manner corresponding to a shared understanding about contributions and payoffs." Thus, it is associated with setting goals and partner inputs for collaboration (Gulati et al. 2012, p. 533–534). Complementing cooperation, coordination is "the deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals" (ibid, p.537). Coordination is therefore concerned with designing information sharing, decision-making, and other operational processes. Interdependent

elements, cooperation and coordination jointly determine alliance success. As organizations enter alliances, they set goals and inputs, coordinate everyday operational processes, and episodically adapt cooperation in response to coordination experience (Doz 1996, Ring and Van de Ven 1994). This makes coordination a key concern of alliances, as inefficiencies and breakdowns in coordination can cause vicious circles leading to collaboration failure (Doz 1996).

2.2 Big data technologies in interorganizational relationships

These dual processes of collaboration are both based on the exchange of information, which are often embedded in and shaped by information technologies (Argyres 1999, Baker and Hubbard 2004, Hitt 1999, Lee and Berente 2012). Interorganizational information technologies allow the explorative and exploitative exchange of knowledge (Im and Rai 2008, 2013), which affects both coordination and cooperation in collaborations. Greater connectivity and insights into partner processes allow more efficient operational processes, which eases coordination (Argyres 1999, Bailey et al. 2012, Baker and Hubbard 2004, Lee and Berente 2012). Simultaneously, greater insight into partner processes allows better control over partner behavior and outcomes, which may change boundary decisions (Aral et al. 2018, Baker and Hubbard 2003, Hitt 1999) or redefine the scope and form of cooperation. While the literature on interorganizational relationships explains these mechanisms well and extensively in the context of traditional small data, the dynamics of interorganizational relationships in the face of digitalization – real-time and big data technologies – remain undertheorized.

Exploring how this new wave of digitalization – that is, real-time and big data technologies – affects organization and the management of interorganizational relationships is important because these new technologies provide considerably greater information-processing abilities and high, increasingly affordable connectivity (Kagermann et al. 2013). Technologies subsumed under the "big data" category facilitate the collection, exchange, and analysis of voluminous and varied real-time data in complex structures (Chen et al. 2012, Jin et al. 2015, Lee 2017). These data tend to be unprompted digital trace data (Lazer and Radford 2017), created by sensors during processes. This trace data is not new, but has been discussed at length as "information" of organizational processes (Zuboff 1988). Where organizations use digital technologies to automate organizational processes, these technologies not only automate said processes, but also automatically create digital traces. Analyzing these trace data renders the

organizational processes they represent knowable and evaluable. For instance, automating a factory floor provides many control values that employees use for operating the production equipment ad hoc. These digital trace data are stored on the equipment's local memory beyond their immediate usefulness to machine operators. With the current wave of "big data" digitalization, organizations have much easier and cheaper access to ubiquitous connectivity and great computing power, which allows more extensive use of these "informated" digital trace data. Greater connectivity and superior computing power allow the affordable collection and analysis of these digital trace data, as well as the remote manipulation of represented processes. Where organizations use these digital trace data to analyze and optimize organizational processes, there is great potential for value creation (Jin et al. 2015, Lee 2017, Mazzei and Noble 2017).

Interorganizational big data technologies build on and extend digital infrastructures (Tilson et al. 2010), which enable complex interorganizational collaboration patterns (Lyytinen et al. 2016). Digital infrastructures are "the basic information technologies and organizational structures, along with the related services and facilities necessary for an enterprise or industry to function" (Tilson et al. 2010, p. 748). When collaborative relationships install interorganizational big data technologies to govern complex interorganizational relationships, these are embedded in organizational and interorganizational digital infrastructures. Collaborations mediated by interorganizational big data technologies benefit from increased transparency over their interorganizational products, processes, and routines and can use the digital infrastructures to optimize the remote communication, coordination, and control of interorganizational processes (Lyytinen et al. 2016). Thus, interorganizational big data technologies afford two elements that can considerably improve interorganizational coordination: *technology-induced operational transparency* (which provides visibility over complex processes) and *digital mediation* (which allows remote digital control over the represented processes).

2.3 Technology-induced operational transparency

Organizations can use digital trace data to create representations of organizational and interorganizational processes, creating technology-induced operational transparency and rendering data analyzable for optimization and innovation (Bailey et al. 2012, Jonsson et al. 2018, Zuboff 1988). For instance, Boland and colleagues (2007) have shown how the move from drawings and other 2D representations to 3D plans in construction projects allows the

efficient exchange of knowledge. Providing greater transparency over the design specifications, such rich, detailed data can inspire unexpected innovation. In fact, the richer the data exchange, the more complex interorganizational tasks organizations can manage. Where engineers collaborate on research and development for automobiles, their collaboration through the virtual creates and leaves digital traces. Drawing on virtualized car-design data, engineers can more easily design and execute product development experiments through the virtual. The results of these digital experiments are stored for future analysis. Referring to past experimentation, engineers can more easily and systematically design new experiments taking into account past experience. Thus, engineers can make use of product transparency and digital mediation to control the product development process. (Bailey et al. 2012). With the diffusion of interorganizational big data technologies, managers from collaborating organizations can optimize their interorganizational interactions in many domains in a similar way (e.g., the provision of predictive maintenance services, the design of new products or services, consulting services for optimized equipment usage and factory operation). In each of these examples, a formerly difficult-to-know process is codified, measured, and represented, providing technology-induced transparency in the form of concrete performance indicators. This makes it easier for employees of partnering organizations to engage in complex interactions surrounding the equipment made visible by digital trace data. Digital trace data add another element to such improved coordination: They increasingly facilitate real-time engagement around specific complex interorganizational tasks.

Technology-induced operational transparency provides concrete objectified numbers and indicators that capture complex organizational and interorganizational processes. Simplifying complex organizational realities, these numbers and indicators can have a strong effect on partnering organizations' employee interactions (Espeland and Stevens 2008, Mazmanian and Beckman 2018, Orlikowski and Scott 2013). These numbers and indicators steer employees' attention toward specific issues of collaboration (Ocasio 1997, 2011). Hence, as interorganizational big data technologies produce new levels of technology-induced operational transparency, focusing partnering organizations' attention on new issues, interorganizational relationships and their management are likely to change.

2.3.1 Interorganizational technology-induced transparency as a harmonization tool

The implications of big data technology for collaborative relationships depend on how the organizations use these technologies. Big data technologies' material properties provide a range of affordances to knowledgeable actors in organizations, each of which might perceive and use them differently (Leonardi 2011). For instance, the same piece of equipment or digital technology may have the same material property to collect different digital trace data, but different organizations may perceive them differently and choose to collect only a subset of such data, analyze them differently, or exploit them some other way. As a result, a technology with the same material properties can be used to visualize different processes in different ways and for different purposes in different organizations. The exact form and use of a technology are therefore dependent upon human agency. Thus, material and human agency become imbricated and interorganizational big data technologies can take many shapes in collaborative relationships (Leonardi 2011). The way a technology is set up invites and constrains certain uses that users cannot completely or directly control. This produces a materiality that brings about certain outcomes; in other words, the technologies' materiality acts and brings about performative effects (Leonardi 2012, p. 36). In this dissertation, the performative effects of technology adoption are different kinds of technology-induced transparency produced by the imbrication of material and human agencies, which might in turn affect interorganizational relationships differently. It is therefore of great importance to distinguish between different kinds of interorganizational big data technologies and the technology-induced operational transparency they produce.

To understand the forms, mechanisms, and effects of transparency, it makes sense to adopt a fine-grained situational definition of transparency. Transparency always has an observing and an observed entity and the configuration of who observes whom or what affects the effects of transparency (Bernstein 2017). This makes transparency context-dependent (Albu and Flyverbom 2019), where the position and knowledge of both the observer and the observed determine how accessible insights from transparency are (Schnackenberg and Tomlinson 2016, Stohl et al. 2016). In this dissertation, I consider operational transparency as created by digital trace data over specific interorganizational processes. This makes organizations the observer, or audience, and interorganizational processes the object of transparency. Organizations use their relationship-specific digital trace data to create targeted transparency (Fung et al. 2007): they reveal specific, rather narrowly defined

interorganizational processes. Such applications of technology-induced organizational transparency aim to visualize, analyze, and optimize specific business processes (Davenport 2014, Schildt 2017). The purpose of this targeted technology-induced transparency is therefore to optimize the observed process – transparency is created as a harmonization tool.

Harmonizing dispersed tasks and actions in interorganizational coordination is challenging, because an organization generally has a more limited view of its partners' processes than of its own internal processes (Alexy et al. 2013, Jarvenpaa and Majchrzak 2016, Williamson 1981). In order to coordinate and harmonize tasks successfully across organizational boundaries, then, organizations need to establish effective routines (Oliveira and Lumineau 2017, Zollo et al. 2002) to exchange and process information (Argyres 1999). Interorganizational technology-induced transparency eases the challenges of producing effective routines and information exchange: It creates accountability, predictability, and common understanding between partners. These are key conditions of coordination (Okhuysen and Bechky 2009). Technology-induced transparency shows where in the process issues occur and allocates each subtask to one partner (accountability), it allows organizations to reduce uncertainty over the timing of interdependent tasks by linking revealed subtasks (predictability), and provides a representation of the tasks, their division, and their current and desired state to both partners (common understanding). Research on coordination has traditionally focused on achieving efficiency improvements by adjusting organizational design, whereas more recent research focuses instead on the processes through which coordination happens despite prevailing organizational design (Okhuysen and Bechky 2009). The type of big data technologies investigated in this dissertation appears to reorient toward traditional interests of reducing interdependencies and uncertainty by improving workflow design. However, with transparency-inducing big data technologies, this is no longer limited to manufacturing products (c.f. Okhuysen and Bechky 2009), but increasingly also digitally mediated services.

Technology-induced transparency therefore can be said to provide a representation over complex interorganizational processes, providing a new kind of boundary object (Star and Griesemer 1989). Boundary objects are objects, such as repositories, labels, ideal types, or other representations of a given phenomenon, that sit between and help connect different problem-solving contexts (Carlile 2002, Star and Griesemer 1989) by providing a shared understanding of the problem. Thus, by observing technology-induced transparency, managers from collaborating organizations can work together more effectively to optimize

specific identified interorganizational processes. Organizations can use technology-induced transparency as a harmonization tool to better govern operational risk.

2.3.2 Technology-induced transparency bridges organizational boundaries

Managers engaging in interorganizational relationships need to span various boundaries. Three of these boundaries that are affected by technology-induced transparency embedded in digital infrastructures (Tilson et al. 2010) are knowledge boundaries (Carlile 2002, Grant 1996, Santos and Eisenhardt 2005), efficiency boundaries (Santos and Eisenhardt 2005, Williamson 1973, 1981), and power boundaries (Pfeffer and Salancik 2003, Santos and Eisenhardt 2005). Each of these boundaries defines an organization and its reach differently, yet they are interrelated. Furthermore, technology-induced transparency and digital mediation may affect each boundary differently.

Each organization integrates the specialist knowledge of its members, creating an organization-specific stock of integrated and shared knowledge (Grant 1996), encoded at the organizational level into routines and practices (Feldman and Pentland 2003, Kogut and Zander 1992, Winter 2003). The distinction made between organizational members and non-members along this line marks an organization's knowledge boundary; in other words, organizational members have access to the organization-specific knowledge base and non-members do not. As managers in interorganizational collaborations interact, they need to overcome three types of knowledge boundaries (Carlile 2002), each dealing with a different kind of knowledge that needs to be shared across organizations. First, there is a simple information asymmetry stemming from the organizations' different points of view. Such rather technical information boundaries create information asymmetry simply because information is shared more easily within organizations than across them (Kogut and Zander 1992). As each manager only has direct access and visibility over those processes occurring within their own organization, they cannot equally easily access the partner organization's knowledge base. These are syntactic boundaries, where managers share a common syntax and only need to overcome information asymmetry. In these cases, information can be simply shared to overcome the knowledge boundaries: All actors share enough common knowledge to understand the shared information. Interorganizational technology-induced transparency can be purposefully designed to tackle this information boundary, automating information exchange and harmonizing dispersed tasks and actions across partnering organizations.

Yet, there are also more complex knowledge bases, which require the sharing information across the syntactic knowledge boundary, as well as translating this information for the other organization's context and value base. Organizations have access to distinct knowledge which is embedded within its context. When organizations exchange this information, they need to recontextualize this information. This translation of information from one knowledge community to another symbolizes the crossing of semantic knowledge boundaries. Where organizations are rooted in different knowledge bases, they need to translate their knowledge across communities. The most advanced knowledge boundary type are pragmatic boundaries. Here, differences in knowledge bases are coupled with differences in value bases, making clear translation of knowledge even more complex. Managers in partnering organizations need to both translate knowledge across different knowledge bases and simultaneously negotiate their differences in value base. Whether the automated and real-time nature of technology-induced interorganizational transparency is equally effective on these two more complex knowledge boundaries is unclear. Exchanges involving translation of knowledge and values might prove more difficult, and more difficult to automate.

Closely related to the spanning of knowledge boundaries is the spanning of efficiency boundaries. Efficiency boundaries mark both the point where a transaction incurs the lowest transaction cost and represent sources of governance costs; different organizations not only have their own knowledge bases to span (which attracts coordination costs) but also broader transaction and monitoring costs (Santos and Eisenhardt 2005, Williamson 1973, 1981). Consequently, complex, interdependent and difficult-to-measure transactions are often conducted within an organization (Baldwin 2008). Determining the transactions that are more efficiently governed inside or outside the legal organization defines these efficiency boundaries. Mediating transactions by interorganizational big data technologies allows the codification of transactions, reducing mundane transaction costs (Langlois 2006). Furthermore, this mediation often goes hand in hand with the (at least partial) automation of transactions and allows the automated capture of digital traces describing these transactions, which reduces monitoring costs. Where complex transactions were historically conducted within an organization, contemporary technology-induced transparency and digital mediation may allow the cost-efficient transcendence of such efficiency boundaries.

Technology-induced transparency also spans power boundaries, which denote the sphere of influence of an organization (Pfeffer and Salancik 2003, Santos and Eisenhardt 2005). An organization's hierarchy has more control over its own management than that of

external partners (Coase 1937, Williamson 1973), yet organizations do at times succeed in holding sway over partners (Pfeffer and Salancik 2003, Santos and Eisenhardt 2009). Where technology-induced transparency provides greater process insights and is used to improve harmonization of dispersed tasks and actions between partnering organizations, it can subsequently turn into a control tool. One challenge in interorganizational relationships arises from information asymmetry and the attendant risk of one partner pursuing its own interests at the expense of the others, sometimes by deceit (Williamson 1981). Where an organization occupies a dominant position in the relationship (Huxham and Beech 2008) or has access to effective controls (Das and Teng 2001, Eisenhardt 1985), it has a way to manage the associated risks. Interorganizational big data technologies may directly increase an organization's de facto power over its partners' internal processes by automating part of its operations or indirectly increasing its influence over its partners by providing more exact output or behavior control mechanisms. The latter occurs as the organization utilizes technology-induced transparency over interorganizational processes to monitor outcome quality and to ensure that agreed-upon tasks occur as contractually specified.

2.3.3   Technology-induced transparency as a control tool

As the above literature review shows, technology-induced transparency is both a harmonization and control tool. It acts as a harmonization tool when spanning knowledge and efficiency boundaries, and as a control tool when spanning efficiency and power boundaries. When organizations use technology-induced transparency as a control tool, it affects more strongly the second aspect of collaborations: cooperation. With an improved ability to control their partners, organizations can manage relational risk more effectively. As organizations in alliances engage in episodic reevaluation of cooperation decisions, they reflect on coordination experience as well as efficient governance mechanisms at their disposal to promote their interests and ensure that they can capture what they consider their "fair share" of the value created in the collaboration.
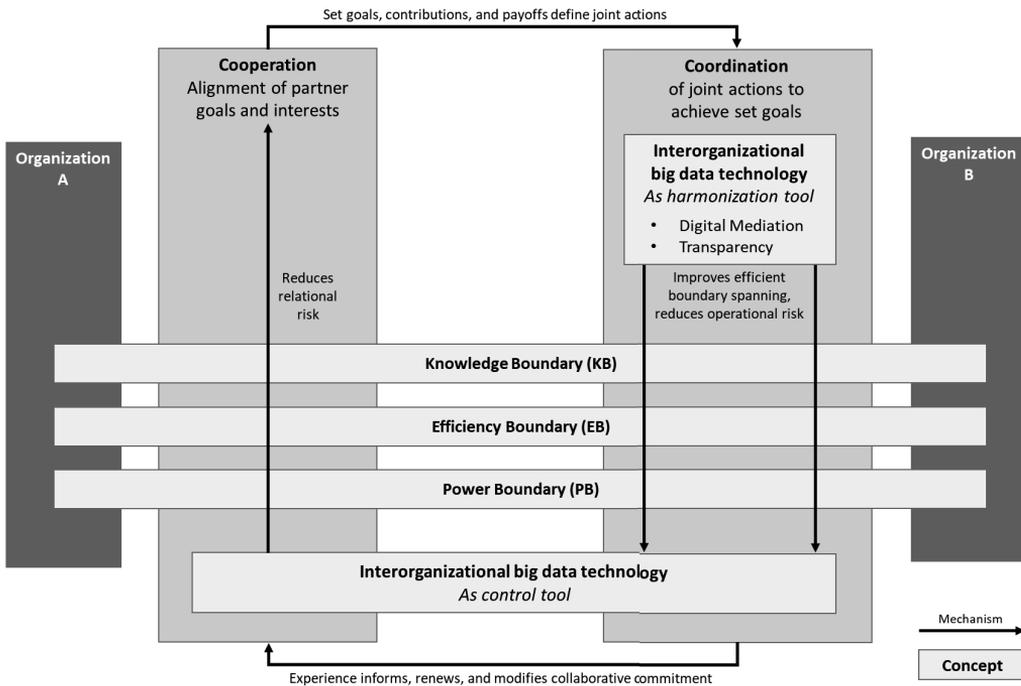
Figure 2: Summary of literature review – Big data technologies in interorganizational relationships

I have shown in this section that interorganizational big data technologies and the technology-induced transparency they yield provide new, more efficient forms of coordination and control in interorganizational processes. These improved coordination and control mechanisms allow the more effective management of relational and operational risk. In particular, two characteristics of interorganizational big data technologies afford these new governance mechanisms. First, technology-induced transparency acting as a boundary object allows improved information sharing and processing across organizational boundaries. Second, digital mediation provides the technical ability to share and process information, as well as to remotely manipulate visualized interorganizational processes (see Figure 2). Assuming that all the benefits of more economic knowledge and efficiency boundary spanning materialize, what are the broader effects of introducing interorganizational big data technologies and their accompanying technology-induced transparency? How does the extension of efficiency and power boundaries affect interorganizational relationships and their management? In what way does improved coordination alter cooperation and through which mechanisms?

3. Methodology

To address these questions, I chose a qualitative research design. Qualitative research is ideal to address new empirical phenomena (Eisenhardt 1989) and to describe mechanisms between complex constructs. To bring to life these constructs and their connections, I draw on rich descriptions and nuanced insights by knowledgeable informants (Graebner et al. 2012). Interorganizational big data technologies may be on the rise, but they are still developing. This poses two challenges requiring qualitative methods. First, there is a lack of conceptual clarity of the phenomenon. Organizations' definition and recognition of what constitutes an interorganizational big data technology varies. My preliminary interviews showed that, to pinpoint such technologies within organizations, I would need to immerse myself in individual cases as it usually took one or two interviews to identify a relevant technology and relationship. Second, there are issues related to data access. Organizations consider these technologies strategically important and may be reluctant to talk openly about them. It was therefore important for me to establish trust with the case companies to access the detailed insights needed to study these technologies.

3.1 A multiple case study design

I conducted a multiple case study (Eisenhardt 1989, Yin 2014). This allows for replication and extension of cases, thereby teasing out shared and complementary aspects of a phenomenon across different settings (Eisenhardt 1991). This allowed me to identify abstract constructs and relationships that could be defined and measured in "objective" terms (Graebner et al. 2012, p. 279). Consequently, my results become more robust, generalizable, and testable (Eisenhardt and Graebner 2007, p. 27). The multiple case logic is particularly interesting for demonstrating general effects of all (or at least most) interorganizational big data technologies and those that tend to differ based on more granular differences in technology set-up. The two empirical essays in this dissertation pursue both of these objectives: In Essay 2, I adopt an embedded case logic (Yin 2014) and analyze the broader effects of interorganizational big data technologies for managing collaborative tensions that hold across interorganizational relationships. My unit of analysis in this essay is the analytical case (Ragin 1992) of one type of "interorganizational big data technology" as observed through five empirical cases of buyer–supplier relationships. In Essay 3, I conduct a comparative multiple case study (Eisenhardt

1989, Yin 2014) and, taking the case relationship as unit of analysis, analyze how different forms of technology-induced transparency affect the development of interorganizational trust.

3.2   Empirical setting

My empirical setting is the Northern European industrial services and manufacturing sector. I analyze how the introduction of real-time big data-based interorganizational processes such as "predictive maintenance" or "efficiency consulting" affects existing industrial buyer–supplier relationships. In both cases, sensors attached to heavy machinery used in industrial production of products or services collect real-time ambient and operations data on-site and transmit them back to the buyer, the supplier, or both partners. One organization then analyzes the equipment's sensor data for operational inefficiencies, focusing on identifying ways to optimize equipment use and maintenance patterns, and subsequently provides adjustment recommendations. To illustrate, "predictive maintenance" is where organizations replace scheduled maintenance procedures (based on independent, factory-prescribed standards) with data-based predictive maintenance schemes (based on analysis of sensor data) to provide needs-based maintenance of groups of equipment, taking into account overall site productivity. In "efficiency consulting," the operator of a factory may employ a variety of different machinery in their production processes. Whereas before, factory workers have used their experience and tacit knowledge to operate machinery, decisions on how to operate machinery are now informed by analytics of real-time sensor data to improve operational efficiency. I consider these sensor technologies at the relationship level, which can take two forms. First, where sensor data are mainly used internally to optimize organizational processes, the sensor data can give a base for evaluating the equipment provider's quality as a partner. Second, in cases where organizations use these sensor data to optimize interorganizational processes, it can give detailed insights about the interorganizational processes themselves as well as the ability of the partner to execute these processes.

Ultimately, both "predictive maintenance" and "efficiency consulting" provide opportunities to save costs and conceive new avenues for value creation. The technologies are similar across all my cases: While relationships may use different operating systems to facilitate the processes, the motivation of installation (efficiency improvement) and the technology's functionality (to provide insight and guidance on machinery use) are the same. While these sensors might have been introduced decades ago for ad hoc equipment operation and control purposes, improved connectivity and computing power – as well as greater interest

in potential gains of analyzing them (Kagermann et al. 2013) – now lead firms to apply advanced analytics algorithms to these data in search of broader business applications.

3.3   Data

The main source of data for this study is semi-structured interviews, altogether 64 semi-structured interviews (25–130 minutes each) in 10 organizations. My questions focused on identifying a suitable big data technology as deployed in a given relationship, its functionality, and the interactions with the partner organization surrounding its use. Additionally, I asked for general relationship descriptions and appraisals, as well as how the use of the technology has changed any aspect of the relationship. Altogether, I discussed seven relationships in detail (see Table 1).

Table 1: Case relationship and data information

	1	2	3	4	5	6	7
Focal firm	Customer large firm	Customer small firm	Supplier large firm	Supplier large firm	Customer large firm	Supplier small firm	Customer large firm
Supplier's industry	Equipment A	Equipment A	Equipment B	Equipment C	Services A	Services B	Equipment D
Customer's industry	Services C	Services C	Services A	Services C	Services A	Services A	Services D
Transaction object	Repeat purchase	Repeat purchase	Ongoing service	Ongoing service	Ongoing service	Ongoing service	Ongoing service
Interviews: focal firm	MM: 1 (1) OM: 6 (4)	TM: 1 (2) MM: 2 (2) OM: 2 (2)	TM: 3 (3) MM: 0 OM: 11 (9)	TM: 1 (1) MM: 2 (2) OM: 9 (5)	MM: 4 (3) OM: 3 (3)	MM: 2 (2) OM: 6 (6)	MM: 4 (3) OM: 3 (3)
Interviews: counterpart	MM: 1 (1)	OM: 2 (2)	n/a	n/a	n/a	OM: 1 (1)	n/a
Analyzed in Essay 2			X	X	X	X	X
Analyzed in Essay 3	X	X	X	X	X	X	

Notes:
TM = Top Management   n = number of interviews = 64
MM = Middle Management   (n) = number of interviewees = (55)
OM = Operational Management

I selected case companies that were prominent in their industry or that spoke openly about their digitalization efforts in the media. My initial entry points were CEOs, Chief Digital Officers, or other personnel in charge of digitalization, thereafter I used snowball sampling (Patton 1990). I started analyzing my data once I had collected about half and then made minor modifications to the remaining data collection based on the insights gathered.

To triangulate these data, I used publicly available archival material, such as corporate websites that describe the organizations' digital strategies, other external corporate

communications concerning their attitudes toward new technologies such as sensor data and big data, and product/service videos that display the interorganizational technologies. Where possible, I also tried to triangulate insights by interviewing managers in the partner organization, however this was not always possible because some organizations were reluctant to provide this access: Organizations consider their investments in (inter)organizational big data technologies secret and highly strategic, therefore dyadic data collection was difficult. This made me change my unit of analysis from the relationship to how one focal organization manages a given interorganizational relationship.

3.4   Data analysis

I pursued an abductive approach to analysis, where I started by looking at how large industrial organizations use big data technologies. At first, I defined "big data technologies" broadly so as not to constrain interviewees' views of relevant technologies. Within the first interviews, I noticed that some of the most advanced big data technologies were Industrial Internet applications using digital real-time data to optimize interorganizational service provision. I found this interesting, because it was not what I initially imagined when I thought of big data. Having decided to focus on these interorganizational digital real-time data technologies, I focused my data collection on describing the artifacts, practices, and knowledge (Leonardi 2007, 2011, Orlikowski and Scott 2008) that constitute these technologies.

My initial data analysis was inductive. I started by reading the interview transcripts and identified interesting themes. Through an iterative analysis, going back and forth between and within cases, I gained a thorough understanding of each individual case, as well as some degree of analytical generalizability across similar cases (Eisenhardt, 1989; Yin, 2013). For this, I defined the interorganizational digital real-time technology in each case, its uses, and local effects on the relationship and its management. Following such deep analysis of each case relationship, I compared it to other case relationships. As my analysis progressed, I referred to existing theory to guide my analysis. This iterative analysis of empirical material and existing literature helped me identify theoretically insightful similarities and differences across cases.

3.5   Defining the foci of my empirical essays

Through my analysis, I noticed similarities and differences across the different interorganizational big data technologies. All case relationships implemented their

technologies to pursue efficiency optimization through better governance, and all realized cost savings or greater understanding of (inter)organizational processes. Yet, there also seemed to be differences in the smaller set-up of interorganizational big data technologies that appeared to affect the development of trust between partners. I took this observation as my starting point to write two types of empirical essay: one analyzing similarities and one analyzing differences across cases (see Table 2).

Table 2: Analysis of case relationships in two empirical essays

Object of transparency Audience of transparency	Monitoring processes and associated performance outputs	Monitoring processes and associated performance outputs and collaborative behavior
Internal display, analysis, and response to transparency	**Essay 3** Two case relationships (#1, #2)	Theoretically possible but unlikely in practice
Interorganizational display, analysis, and response to transparency	**Essay 3** Two case relationships (#3, #4) _____ **Essay 2** Five case relationships (#3, #4, #5, #6, #7)	**Essay 3** Two case relationships (#5, #6) _____-

In my first empirical essay (Essay 2), I explored similarities across my empirical cases. Five of my empirical case relationships implemented a similar interorganizational big data technology to improve governance of specific interorganizational processes, all judged successful. One partner in the relationship used an interorganizational big data technology to create transparency over specific equipment or interorganizational processes provided by its partner and displayed this transparency both internally and for its partner to optimize specific interorganizational processes. All empirical case relationships demonstrated successful technology implementation and a strong focus on achieving optimized efficiency of selected interorganizational processes. To explain how this observation can occur across different cases, I adopted an embedded case study approach to analyze the analytical case (Ragin 1992) of *this kind of interorganizational big data technology* through my five empirical cases (see Essay 2: #3, #4, #5, #6, #7). The focus of this essay was on how collaborative relationships used the interorganizational big data technologies to optimize day-to-day governance. My analysis showed the mechanisms through which digital real-time data focused employees' attention and

privileged swift reactions to operational concerns, and how this suspended collaborative tensions.

In my second empirical essay (Essay 3), I analyzed differences across cases. For this, I zoomed in on more granular differences in technology set-up to identify and examine variance across cases. For this, I distinguished between technologies that created varying levels of transparency (only output quality or partner behavior) to different audiences (internally to the observing organization or externally to the observed partner). I identified three types of interorganizational big data technology set-up. In two case relationships (Essay 3: #1 and #2), the customer organization used the technology to observe suppliers' performance, but did not share this insight with the suppliers. In two case relationships (Essay 3: #3 and #4), the supplier organization used the technology to observe its own performance, shared this insight with its customer, and used it to jointly optimize specific interorganizational processes. In two other case relationships (see Essay 3: #5 and #6), one organization used the technology to observe the performance of a specific interorganizational process, shared this insight with its partner, and used it to jointly optimize this process. Moreover, they used the technology to observe whether and how recommendations for optimizing the process are implemented, monitoring behavior as well as performance. Digging deeper into cross-case analysis among these six case relationships, the themes of trust, control, and coordination emerged. This led me to adopt a comparative multiple case study logic (Eisenhardt 1989, Yin 2014) to explore how different interorganizational big data technology set-ups engender varying types of technology-induced transparency, and how these affect the development of interorganizational trust.

4. Three essays on digitalizing interorganizational relationships

To address my overarching research question of how interorganizational big data technologies affect interorganizational relationships and their management, I first conducted a conceptual analysis of the organizational powers of interorganizational big data technologies and theorized their effects on collaboration process dynamics (Essay 1). In my two empirical essays, I explored two of those effects in greater depth. In Essay 2, I find that organizations deploy interorganizational big data technologies to improve daily governance of interorganizational routines and suspend interorganizational tensions locally. In Essay 3, I show how interorganizational big data technologies modify how an organization perceives its partners and how this changed perception affects the development of trust. Together, the three essays show that interorganizational big data technologies often deliver the operational optimization they promise, but that effects on collaboration are more far-reaching than initially expected. Organizations ought to be aware of these broader changes if they are to benefit from the optimization that such technologies offer.

An underlying finding of my empirical work is a description of how interorganizational big data technologies create technology-induced operational transparency. This transparency is the starting point from which we can observe the broader changes in managing interorganizational tensions and developing interorganizational trust.

4.1 Essay 1

Technological embeddedness in interorganizational collaboration

Katharina Cepa & Henri Schildt, accepted for publication in "Research in the Sociology of Organizations," volume on interorganizational collaboration processes

In the first essay of this dissertation, together with Henri Schildt, I situate the phenomenon of interorganizational big data technologies within the broader alliance literature. We draw on conceptualizations of big data technologies (Chen et al. 2012, Lee 2017, Yin and Kaynak 2015) and digital infrastructures (Lyytinen et al. 2016, Tilson et al. 2010) to describe how digital real-time data create or increase "technological embeddedness" in interorganizational relationships. We conceptualize technological embeddedness as a characteristic of interorganizational relationships that denotes "the degree of monitoring,

control, and optimization of intra- and interorganizational tasks accomplished through technology at the interface of the interorganizational relationship" (p.62).

Greater technological embeddedness augments interorganizational collaboration processes through richer data flows, which enable better coordination and control between partners. Building on this conceptualization, we theorize how increasing big data technology-based technological embeddedness affects the development of trust (Connelly et al. 2018, Gulati 1995, Stevens et al. 2015, Zhong et al. 2017), mutual adaptation (Deken et al. 2018, Dyer 1996, Dyer and Singh 1998), and temporal structuring (Orlikowski and Yates 2002) in interorganizational relationships, and illustrate this theorization with empirical observations from my dataset.

This first essay conceptualizes the empirical phenomenon of "interorganizational big data technologies" as the theoretical phenomenon of "interorganizational digital real-time data transfers" enabled by greater or lesser degrees of what I term "technological embeddedness" in Essay 1. Technological embeddedness serves as a digital organizational infrastructure and precondition for the changes in interorganizational processes I discuss in my two empirical essays. More specifically, increasing big data technology-based technological embeddedness provides an alternative to how organizations can manage interorganizational tensions (see Essay 2) and adds to our understanding of the development of trust in interorganizational relationships (see Essay 3). Thus, this first essay lays the conceptual groundwork for empirical investigation in the second and third essays.

4.2 Essay 2

Engineering collaboration with digital data: How orthodox spaces suspend interorganizational tensions

Katharina Cepa & Henri Schildt, working paper

The second essay in my dissertation explores how organizations can use interorganizational big data technologies to manage interorganizational tensions. Prior literature has elaborated how information technology can be leveraged to resolve governance issues (Aral et al. 2018, Baker and Hubbard 2004, Hitt 1999, Malone et al. 1987). However, information technology's effects on the underlying tensions and paradoxes of collaboration remained largely unaddressed. The tensions posed by competing and incompatible goals and

objectives within the collaborating organizations themselves are intrinsically different from problems of governance that arise from opportunism between the partners (Das & Teng, 2000). Thus, to create better understanding of the role of digital real-time data for facilitating interorganizational collaboration, my co-author and I posed the following question: *"How do real-time digital data flows structure and shape internal tensions in interorganizational collaboration?"*

Our findings show how organizations use interorganizational digital real-time data flows to construct what we term "orthodox" spaces. These are "islands of collaboration" where partnering organizations use digital real-time data to leverage their data-driven mindset and establish technologically embedded interactions to suspend collaborative tensions. Within orthodox spaces, managers work toward a subset of collaborative goals, that is, they focus on only one end of the continuum of competing collaboration needs (cf. hybrid spaces in Perkmann, McKelvey & Phillips, 2019). Digital real-time data support and direct this narrow focus, which allows successful close collaboration between the operational employees of partnering companies.

We contribute to theory by identifying orthodox spaces as a confined version of separation (Brattström and Richtnér 2014, Klarner and Raisch 2013) and mirroring the confined integration approach of "hybrid spaces" (c.f. Perkmann et al. 2019) to managing interorganizational tensions. We present a process model that shows how organizations can use interorganizational big data technologies to create a data-based organizational design that manipulates multiple tensions concurrently. This also provides a more dynamic understanding of tensions (Fairhurst et al. 2016), because it shows the interconnectedness of collaborative tensions: Organizations simultaneously suspend long-term orientation, information hoarding, and competitive concerns in favor of short-term orientation, information sharing, and cooperative concerns.

4.3   Essay 3

Transparency technologies and interorganizational trust: How observers use transparency to coordinate and monitor partners

Katharina Cepa, working paper

This essay explores how the introduction of interorganizational big data technologies brings about varying types of operational transparency and how these affect the development of interorganizational trust. Interorganizational big data technologies, such as "predictive maintenance" and "efficiency consulting," provide real-time insights into complex operational processes of partner organizations, which allows optimized coordination and control of interorganizational processes. Automating interorganizational interactions, they chronicle interaction details as digital traces (Lazer and Radford 2017) and provide detailed virtual representations of relationships (Bailey et al. 2012). Thus, such transparency is operational and provides accurate, clear, and timely insights and should therefore foster development of interorganizational trust (Schnackenberg and Tomlinson 2016). Organizations often implement such technologies with the primary aim of coordinating interorganizational tasks and knowledge exchange, which should consolidate interorganizational trust (Malhotra and Lumineau 2011, Vélez et al. 2008) provided partners show trustworthy competence and behavior (Mayer et al. 1995). Yet, literature remains silent on the processes through which technology-induced transparency should increase such trust, on the question of whether transparency for the purpose of coordination can be reapplied to monitor partners, and whether it changes the pace of trust development.

My findings answer each of these questions by showing how transparency technologies leverage organizations' preference for transparency to reveal interorganizational processes, and how this changes the development of interorganizational trust. The mediation of operations by transparency technologies records process details digitally: Processes are "informated" (Zuboff 1988) to optimize coordination of everyday tasks. As a result, the observing organization gains "objective" insights into partner performance. This insight replaces parts of the observer's competence-based trust in the observed by calculative trust – a change that is visible across all cases and driven by the development of institutional trust in the transparency technology. Where organizations only use these transparency technologies internally to assess partner quality (in two out of six cases), it seems not to affect relational trust. However, where organizations make transparency visible across both partners and use it to structure interorganizational processes (in two out of six cases), balancing these insights against goodwill-based trust becomes more challenging. In some cases (two out of six), the informated processes also monitor partner openness and honesty, rendering behaviors and reactions – both previously opaque aspects – controllable. Specifically, in these cases the transparency technologies record how partners react to optimization recommendations,

whether they respond to and implement them or not. In these cases, building goodwill-based trust becomes relatively more expensive as it is constantly measured against recorded operational performance. The controls I observed differ from governance mechanisms previously discussed in the literature (Lumineau and Henderson 2012, Malhotra and Lumineau 2011) in terms of timing, purpose, and production. Controls in this study are not contract clauses written purposefully for either monitoring or coordinative control when starting a collaboration. Rather, they occur naturally, almost accidentally, as metrics produced by everyday coordination of tasks and organizations can switch between using them for harmonization or monitoring.

I contribute to the literature on interorganizational trust by illuminating the mechanisms by which different types of technology-induced operational transparency affect the composition and development of such trust. These findings also advance the conversation around trust and control (Lumineau 2017, Vélez et al. 2008, Woolthuis et al. 2005) showing that, in some cases, they can start out as complements only to become substitutes. Furthermore, I argue that to enable long-term innovation, organizations should establish strong goodwill-based trust in selected relationships to overcome potentially revealed short- and medium-term setbacks in operational performance.

4.4   Answers to the research questions

My three essays each address one of the three sub-questions presented in Chapter 1 (see Table 3). In Essay 1, I answer Research Question 1 and conceptualize how the interorganizational capture, creation, and exchange of relationship-specific digital real-time data creates greater degrees of interorganizational *technological embeddedness*. I theorize how such increased monitoring, control, and optimization of interorganizational tasks alter the development of interorganizational trust, mutual adaptation, and temporal structuring between partners. In Essay 2, I respond to Research Question 2 and describe how digital real-time data flows shape collaborative tensions by focusing managers' attention on a subset of collaborative goals. I delineate the mechanisms through which such technological embedding locally suspends collaborative tensions at the process level. In Essay 3, I address Research Question 3 and show how varying degrees of technology-induced transparency affect the development of interorganizational trust. More specifically, I show how the observing partner's trust in its partner dwindles and changes with the automatic availability of greater performance and

behavior controls. Simultaneously, the observed partner recognizes these changes and concentrates on managing them.

Taken together, the essays answer this dissertation's overarching research question of how the introduction and use of interorganizational big data technologies, and their associated technology-induced transparency, affect interorganizational relationships and their management. I have shown that these technologies tend to reach their goal of optimizing interorganizational processes, but that there are wider implications for managing collaborative relationships.

Table 3: Summary of findings, matching essays to research sub-questions

	Research Question 1: *How does the interorganizational capture, creation, and exchange of digital real-time data and "big data" affect collaboration processes?*	Research Question 2: *How do real-time digital data flows structure and shape internal tensions in interorganizational collaboration?*	Research Question 3: *How does technology-induced operational transparency affect the development of interorganizational trust?*
answered by	**Technological embeddedness** **(Essay 1)**	**Engineering collaboration with digital data** **(Essay 2)**	**Transparency technologies and interorganizational trust** **(Essay 3)**
Main concepts	Digital infrastructures (Tilson et al. 2010), automation, and information (Zuboff 1988).	Hybrid spaces (Perkmann et al. 2019) and collaborative tensions (Das and Teng 2000, de Rond and Bouchikhi 2004, Schad et al. 2016).	Interorganizational trust and control (Mayer et al. 1995, McEvily et al. 2017, Vélez et al. 2008) and transparency (Bernstein 2012, 2017, Schnackenberg and Tomlinson 2016, Zuboff 1988).
Method and empirics	Conceptual argumentation with illustrative examples from this dissertation's dataset.	Embedded case study (Ragin 1992, Yin 2014) and grounded theory (Strauss and Corbin 1990). – One analytic case = one type of interorganizational big data technology *observed through* five empirical cases = five case relationships using interorganizational big data technologies.	Multiple comparative case study (Eisenhardt 1989, Yin 2014) and grounded theory (Strauss and Corbin 1990). – Analytical cases equal the empirical cases Six empirical cases = six case relationships using interorganizational big data technologies.
Key findings	Interorganizational digital real-time data transfers create or increase "technological embeddedness," a characteristic of interorganizational relationships that denotes the degree of monitoring, control, and optimization of intra- and interorganizational tasks accomplished through technology at their interface.	Digital real-time data transfers leverage managers' data-driven mindset and embed interactions technologically. Thus, managers suspend long-term orientation, information hoarding, and competitive concerns to focus on the short term, information sharing, and cooperativeness.	Digital real-time data transfers automate and "informate" specific interorganizational processes. Initially a harmonization tool, the resulting performance and behavior transparency also provide controls. Managers increasingly use the information system's (IS) controls over relational experience. Managers' attitude for transparency and a new trust in the IS support these changes.
Propositions	The more efficient monitoring, control, and optimization in relationships marked by greater technological embeddedness has positive and challenging effects on the development of interorganizational trust, mutual adaptation, and temporal structuring between partners.	Interorganizational big data technologies facilitate the exchange of digital real-time data, which creates a data-based interorganizational design, termed "orthodox spaces," that allows the local suspension of collaborative tensions at process level.	Interorganizational big data technologies facilitate the exchange of digital real-time data, which creates operational transparency. This transparency provides automated performance and behavior controls, which tend to substitute the observing party's trust in their observed partner.

5. Discussion and conclusion

This study has contributions for theory and management practice. First, my findings contribute to theories of interorganizational relationships by exploring how digital real-time data technologies create operational transparency and new forms of coordination and control for optimized relationship governance. Beyond that, I delineate specific effects these affordances have for development of interorganizational trust, managing interorganizational tensions, and structuring collaboration processes. Second, these theoretical insights are also valuable to practitioners. My findings provide practical insights for managers who consider implementing interorganizational big data technologies. Specifically, managers should remain aware that, despite governance optimization, alliance challenges rooted in tensions and trust persist: Interorganizational big data technologies complement traditional relationship mechanisms; they do not replace them.

5.1 Theoretical contributions

My dissertation makes a number of theoretical contributions. First, the dissertation as a whole identifies the concept of technology-induced operational transparency and thereby opens up a range of new research avenues. Beyond this broad conceptual contribution, my individual essays provide more detailed, theory-specific contributions. In my conceptual essay (Essay 1), together with my co-author, I bridged the literatures on digitalization, information systems, strategic management, and organization theory to situate the empirical phenomenon of "interorganizational big data technologies" within the scholarly discussion. We did so by conceptualizing "technological embeddedness" as characteristic of interorganizational relationships and theorized potential implications for strategic management and organization theory. My empirical essays (Essay 2 and Essay 3) then explored some of these issues in more detail and advanced the literature on strategic management and organization theory by discussing implications for managing interorganizational tensions and the development of interorganizational trust (see Figure 3). Conflating the findings of my three essays, my dissertation shows conceptually and empirically how technology-induced transparency and digital mediation created by interorganizational big data technologies transform collaborative relationships. This indicates that future research ought to investigate further the various forms and effects of technology-induced transparency across different contexts.
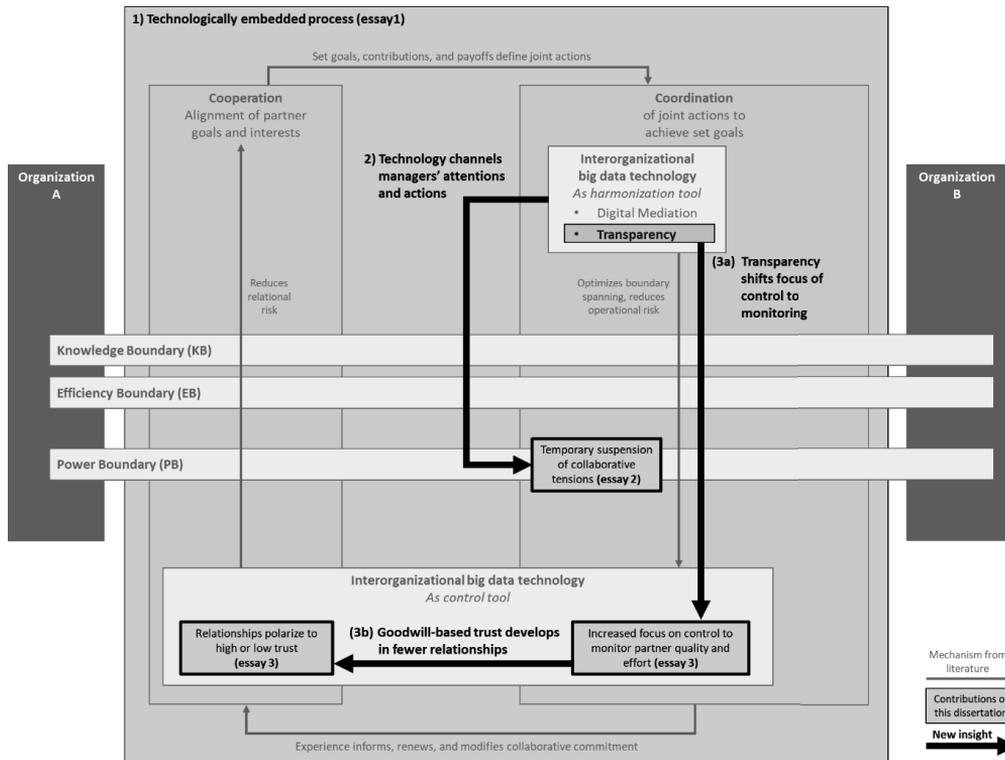
Figure 3: The effects of interorganizational big data technologies and associated transparency on interorganizational relationships and their management

5.1.1 Technology-induced transparency

The most apparent finding across my conceptual and empirical analyses is that of technology-induced transparency as a defining characteristic of interorganizational big data technologies. It is what the technology does in organizations: shine the spotlight on specific digitalized processes and providing targeted transparency (Fung et al. 2007). Highlighting a particular aspect of the interorganizational collaboration process is at the core of implementing big data technologies, from identifying the process to choosing which indicators to measure it and analyzing the process for optimization. Thus, we need to first define what interorganizational big data technologies are to make visible, before we can determine their applications and analyze their effects. Hence, it is an important concept to understand and define when studying interorganizational big data technologies. Transparency is also central, albeit implicit, in the scholarly discussion about big data technologies: From the descriptions of the five V attributes (volume, velocity, variety, veracity, and value) of big data (Chen et al.

2012, Yin and Kaynak 2015) to big data analysis methods (Davenport 2014, Lee 2017, Mazzei and Noble 2017), business use cases (Jonsson et al. 2018, Kagermann et al. 2013) and potential associated societal challenges (Flyverbom et al. 2019, Zuboff 2015), all is effectively premised on the transparency-creating power of big data technologies. In this dissertation, I conceptualize technology-induced transparency within the interorganizational context. This conceptualization is useful because it indicates the source of big data technologies' influence as well as concrete use cases. By starting from what big data technologies reveal, scholars can study these technologies' effects on organization, practitioners can start developing use cases, and critics can identify potential risks of implementing such technologies.

In this vein, my dissertation shows the need to define technology-induced transparency in terms of its object, audience, and purpose. Transparency is not objective, but always constructed from the perspective of the observer with a specific purpose in mind (Hansen and Flyverbom 2015, Stohl et al. 2016). Clearly defining who the audience is (the observing party), what the object is (the observed), and the purpose (e.g., monitoring/control or coordination/optimization) of transparency is crucial for understanding its implications (Bernstein 2017). My literature review has defined the primary object of digital real-time data-based transparency in specific interorganizational processes in buyer–supplier relationships. Furthermore, my empirical findings showed the primary purpose of such transparency to be the harmonization of joint tasks in the coordination realm of collaborative relationships. There was some variance across cases in the purpose, where some focused primarily on optimizing internal tasks (case relationships #1 and #2) and others on optimizing the harmonization of joint tasks (case relationships #3–7). Where the purpose was to optimize internal tasks, the audience was also just one organization. In cases where organizations optimized joint tasks, the audience included both organizations.

In the three essays, I have shown how the detailed real-time insights that technology-induced transparency provides, paired with digital mediation, allows collaborating organizations to more efficiently cross boundaries of knowledge, efficiency, and power. Thus, technology-induced transparency provides the cognitive support and digital mediation the structural support for optimizing (the primary purpose of transparency in this empirical setting) selected (inter)organizational tasks and processes (the primary object of transparency in this empirical setting). Such technology-induced transparency allows collaborating organizations (the audience of transparency) to identify and react immediately to process inefficiencies, drawing managers' attention to concrete interactions around specific tasks.

In my analysis of seven buyer–supplier relationships within the European industrial services and equipment sector, I made three observations with regard to the purpose, object, and audience of technology-induced transparency. First, where organizations used this transparency to optimize the coordination and harmonization of joint tasks (primary purpose) and based their joint analysis on performance outcome metrics (an object of transparency), such focus on shared goals allowed the local suspension of collaborative tensions (see Essay 2). In these cases, which actor – the customer or supplier – initiated and executed this transparency appeared irrelevant for the management of tensions. In their joint optimization, both organizations had access to the transparency (the audience) and all case relationships experienced a local suspension of tensions. Second, my findings indicate that the purpose of technology-induced transparency shifted over time. The automatic generation of outcome and behavior controls for coordination subsequently provides managers with a monitoring and control tool. Irrespective of how successful coordination efforts are shown to be, managers appear to rely more strongly on the secondary – and almost accidental – purpose of technology-induced transparency, which is monitoring (Essay 3). In my empirical setting, organizations created transparency as a harmonization tool (primary purpose) and only over time repurposed it as a control tool (secondary purpose). With this shift of purpose, the organizational consequences of transparency also changed. The increased use of transparency as a control tool then affected the cooperation domain of collaboration. Greater availability of controls provides a new basis for making collaborative commitments. Third, my findings show variance between the effects of technology-induced transparency when the audience of transparency is only one of the partners (Essay 3). Even as the purpose and object of transparency remain the same, the unilateral use and design of such transparency appears to affect its implications for managing relationships.

5.1.2   Technological embeddedness

My dissertation raises the empirical phenomenon of "interorganizational big data technologies" to a theoretical level and discusses them as "digital real-time data technologies" with specific affordances for coordination and control in interorganizational collaboration processes. A major step in doing so was to conceptualize digital real-time data-based "technological embeddedness" as a characteristic of interorganizational relationships. Essay 1 drew together literature on digitalization (Jin et al. 2015, Zuboff 1988), information systems (Jonsson et al. 2018, Lyytinen et al. 2016, Tilson et al. 2010), and transparency (Bernstein

2017, Jonsson et al. 2018) to conceptualize technological embeddedness as characteristic of interorganizational collaboration processes. Denoting "the degree of monitoring, control, and optimization of intra- and interorganizational tasks accomplished through technology at the interface of the interorganizational relationship" (p.67), this new concept provides a base from which scholars can empirically examine the effects of digital real-time data technologies on the nature and management of alliances. The concept captures the key attributes of digital real-time data technologies, namely technology-induced transparency and digital mediation, which provide the cognitive and structural support, respectively, to allow for this improved monitoring, control, and optimization. In an attempt to further this agenda, Essay 1 provides a range of propositions on how greater digital real-time data-based technological embeddedness affects the development of interorganizational trust, mutual adaptation, and temporal structuring of alliances. In addition to theorizing the potential of greater technological embeddedness to generate more valuable interorganizational relationships, the essay also theorizes potential negative implications. Altogether, the propositions I put forth in Essay 1 provide a broad, albeit not exhaustive, avenue for future research.

Technological embeddedness has strong effects on the coordination domain of collaborative relationships, that is, "the deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals" (Gulati et al. 2012, p. 537). In Essay 2, I have shown how partnering organizations technologically embed specific interorganizational tasks and processes. This way, they can use the greater technology-induced transparency and digital mediation to more efficiently govern the coordination of these tasks and processes. Greater technological embeddedness therefore primarily affects the harmonization of joint actions to achieve set goals. My findings have shown that greater technological embeddedness allows improved coordination because it facilitates managers to span their organizations' boundaries of knowledge, efficiency, and power. In Essay 3, I have concentrated specifically on how the technology-induced transparency in technologically embedded relationships facilitates the spanning of power boundaries. With more efficient, automated controls at hand, managers started relying more on monitoring controls for coordinating joint tasks. It is this increased use of controls that also takes effect in the cooperation domain, that is, the setting of goals and partner inputs (Gulati et al. 2012, p. 533–534) of collaborations. In this second instance, organizations use insights generated through the coordination and harmonization of joint tasks for reevaluating cooperation with their partner.

5.1.3 Interorganizational tensions

Interorganizational big data technologies affect collaborative relationships and their management beyond governance and coordination. In Essay 2, I have identified a new approach for managing interorganizational tensions. Managing interorganizational tensions requires negotiation of competing collaborative demands (Putnam et al. 2016, Schad et al. 2016). Organizations often deal with competing collaborative demands by either integrating (Lüscher and Lewis 2008, Stadtler and Van Wassenhove 2016, Zimmermann et al. 2015) opposing needs or entirely separating them (Brattström and Richtnér 2014, Klarner and Raisch 2013). Recent evidence indicates that organizations can benefit from designing organizational structures that purposefully leverage competing demands locally (Perkmann et al. 2019). While such a "contained integration" strategy may be advisable and useful in uncertain situations for which concrete action recommendations are hard to identify (Perkmann et al. 2019, Smith and Besharov 2019), my findings indicate that in situations that are more codified and strongly embedded in digital infrastructures – situations of great "technological embeddedness" – it makes sense to locally separate demands. The findings in Essay 2 suggest that such separation can be done technologically at the process level through what I term "orthodox spaces". In this way, organizations technologically embed specific interorganizational processes into interorganizational big data technologies and manage them through digital mediation. Such a "contained separation" approach proposes a data-based organizational design of benign organizational stupidity (Alvesson and Spicer 2012, 2016), allowing managers to fully concentrate on certain aspects of collaboration while ignoring others. This indicates that the context of tensions is an important determinant to how organizations best deal with them. In the case of decisions and processes that are codified and embedded within digital infrastructures, designing orthodox spaces can be an effective approach to managing collaborative tensions.

5.1.4 Interorganizational trust

The literature on interorganizational trust has long assumed symmetric trust between partners (Graebner et al. 2018, Korsgaard et al. 2015, McEvily et al. 2017) and largely ignored the effect technology has on its development. In Essay 3, I have advanced understanding of both of these areas. My investigation of how different types of technology-induced transparency affect what an organization perceives about its partner has empirically and theoretically shed light on how and why the development of interorganizational trust is

often one-sided (Graebner et al. 2018). Technology, and the transparency it creates, is central to describe this unilateral change in such trust. Trust and technology are deeply entwined because technology-induced transparency has a dual function. First, where digital trace data provide more accurate insights about partner competence and goodwill, greater transparency allows the observing organization to make better trust judgments (Lumineau 2017, Mayer et al. 1995) and reduces the instances when it needs to rely on trust rather than facts (Möllering 2006). This makes digital real-time technologies an (inter)organizational structure that shapes the development of trust (Lumineau 2017, Lumineau and Schilke 2018). Technology-induced transparency is often a coordination device, intended to optimize collaboration processes and increase performance (Schilke and Lumineau 2018). It is only after the digital traces' initial coordinating function is served that organizations use them as a monitoring device. Where controls coordinate, they can complement and increase trust, and where they are monitoring devices, they can substitute and decrease trust (Lumineau 2017, Lumineau and Henderson 2012, Malhotra and Lumineau 2011, Vélez et al. 2008). Thus, in its second function as "coordination-turned-monitoring" device, technology-induced transparency can eventually crowd out trust despite controls showing trustworthy output and behavior – making it a substitute rather than a complement of trust. This shows yet another variant of the effects of quantification and numbers on organizational reality (Espeland and Stevens 2008, Orlikowski and Scott 2013), and how these effects might be far from their original purpose.

My findings show that organizations that made conscious investments in increasing their technological embeddedness by introducing interorganizational big data technologies subsequently developed new trust in these information systems. Once confidence in the technology was established, the performance metrics they produced were taken for granted. This trust in the information system leveraged a general attitude in favor of transparency and pushed organizations to increasingly rely on monitoring performance controls. My findings indicate that this shift is automatic, simply because controls are available, rather than based on managers' conscious decision to trust in numbers rather than experience. As a result, technology-induced transparency substituted competence-based trust. Monitoring controls replaced rather than augmented competence-based trust. This conflicts with prior theory (Malhotra and Lumineau 2011), which could be explained by the type of monitoring controls. These "coordination-turned-monitoring" controls were not originally designed as monitoring controls but were almost "accidentally" produced through coordination. Thus, the initial intention of contractual monitoring controls appears to affect their implications for trust

development. While these kinds of "coordination-turned-monitoring" controls are but a small share of controls in collaborative relationships, they are appearing more frequently as organizations digitalize a growing share of their interorganizational processes. Therefore, understanding how they affect the management of collaborations is of great importance.

This greater use of controls for monitoring also challenges the development of goodwill-based trust. Goodwill-based trust – an organization's positive expectations that their partner would not consciously harm or cheat them (Zhong et al. 2017) – is tacit and develops most strongly through personal interaction. While goodwill-based trust could be measured by the recurrence of shirking behavior or leniency, it is nevertheless premised on managers' active recall of such events. Thus, in everyday interactions, goodwill-based trust is not constantly visible in the form of a metric in the same way that performance and, in some cases, behavior is. This suggests that as technology-induced targeted transparency provides monitoring controls automatically, it tends to replace trust even in cases where partners display trustworthy competence and behavior. With organizations digitalizing an increasing share of their interorganizational tasks and processes, this might have far-reaching consequences. If organizations increasingly rely on monitoring controls to govern relationships, they may start to see them as default governance mechanisms. Yet, collaboration often requires leeway and discretion because not all tasks and processes can be defined a priori. For this reason, organizations need to be able to trust their partners.

5.1.5 Limited diversity and unintended consequences of technology use

My findings provide two novel insights into the outcomes and consequences of new technology adoption in the case of interorganizational big data technologies. First, contrary to prior research that has shown that technologies rarely engender the practices and processes they were intended to produce (Pentland and Feldman 2008), my findings indicate that some interorganizational big data technologies can in fact yield the projected results. Second, prior theory predicts that the same technology would play out differently across cases as human actors resist technologies and modify their use locally (Barley 1986, Boudreau and Robey 2005, Leonardi 2007), however in my study there was little variance across cases. The reasons for this might lie in the type of technology and context addressed: The technologies investigated in this dissertation digitalize very technical operational processes and users of the technology are engineers in engineering companies. Within such an environment and application, users find it generally sensible to use the technology and show less resistance once

they see that the technology provides the promised operational outcomes. Furthermore, the technologies are highly scripted, leaving little space for resistance. Other studies show that users of transparency technologies may resist it by manipulating the input data (Pachidi 2016) but such resistance is practically impossible in the case of digital trace data. Digital traces occur automatically as organizational processes unfold in digitally mediated environments as they chronicle the digitalized process (Zuboff 1988). The only phase in which their recording and analysis is typically contested is during the design phase, which remains outside the scope of this dissertation. Thus, I posit that big data technologies that digitalize processes that are (1) more technical, (2) within more engineering-minded environments, and (3) highly scripted, are more likely to produce the intended outcomes and meet lower resistance from technology users, provided they are executed competently.

5.2 Implications for practice

This dissertation makes two contributions to practice. First, it took a loose concept and made it concrete. In my fieldwork, I was struck by the uncertainty over what constitutes an "interorganizational big data technology." Solutions currently applied and developed in the Northern European industrial equipment and service markets are still far from the science fiction ideas of an all-knowing super-smart system. They also bear little resemblance to the well-known examples from consumer markets such as online advertising, IBM's Watson medical assessment, or social media analyses. Instead, solutions are scattered, referred to broadly as "Industrial Internet," "predictive maintenance," or "smart manufacturing." When talking to practitioners, it often takes a while to find common ground and determine which parts of their operations would qualify as "interorganizational big data technology" or "advanced analytics." Therefore, this dissertation sheds light on one specific type of interorganizational big data technologies and advanced analytics in practice. This expands our empirical knowledge base by allowing deeper analysis of a sub-sphere of the broader phenomenon of interorganizational big data technologies.

Second, organizations are seldom aware of how the introduction of such technologies affects their collaborative partnerships beyond the achievement of greater efficiency and better coordination of interorganizational tasks. Organizations in this study concentrated on the objectives of the technology, giving little thought to how the resultant changes in collaboration practices affect the broader management relationship. I have shown how the greater transparency, coordination, and control produced by these interorganizational

big data technologies affects the management of inter-partner tensions and the development of trust between partners. This highlights that, while interorganizational big data technologies often deliver the optimization value they promise, managers need to be aware of the effects this has for interaction dynamics and relationships more broadly. Specifically, I have shown that managers' foci of attention might be temporarily moved (Essay 2) and that these technologies affect how interorganizational trust develops (Essay 3). Building on prior literature, I have also theorized potential implications for temporal structuring and mutual adaptation (Essay 1), suggesting that managers should look beyond immediate operational efficiencies to better understand their alliance partners. In particular, it is relevant to understand how managers' appreciation and evaluation of their partner organization might have shifted, and whether and how their partner's appreciation and evaluation of their own organization has changed. Only where managers pause to analyze the digitalized relationships and their dynamics can they be sure to adopt the right practices around technology use and broader partner interactions. As an increasing share of organizations implement interorganizational big data technologies, making managers aware of these changes is crucial for guaranteeing that the initial benefits of optimization will not be thwarted by their implications for relationship management.

5.3 Limitations

Although my dissertation has tackled an empirical phenomenon of importance to the development of strategic management and organization theory – as well as to practitioners dealing with technology investment and implementation decisions – this is a qualitative study with limited generalizability. My findings are analytically transferable to similar contexts, but not beyond. The empirical setting in a technologically well-developed geographic area with industries that show high relationship-specific investments pose two important boundary conditions. First, increasing technological embeddedness through digital real-time technologies requires broader digital, and other, infrastructures to produce similar results. In less technologically developed geographic areas similar results would be unlikely. Furthermore, this connects to the broader cultural context in which my study took place. Northern European industrial equipment and service sectors might prove more willing to adopt the new processes my essays described. Organizations in a different cultural setting might choose to adopt different processes, or not. Second, the high relationship-specific investments in the industrial equipment and service sectors command long-term partner management strategies (Dyer and Singh 1998, Williamson 1991). As organizations are bound to the partners

providing high relationship-specific investments, they might react more cooperatively to the introduction of digital real-time data-based interorganizational processes. In fact, from the outset, they might be more willing to adopt such technologies to improve interorganizational processes that they know they will need for a long time.

For further validation of my empirical findings, a larger-scale quantitative study could be conducted in which both the cultural aspect and the application to other industries and geographical areas could be tested. In particular, it would be interesting to analyze how interorganizational big data technologies unfold in settings with (a) lower relationship-specific investments or (b) where the relationships are no longer dyadic but mediated by the presence of third parties providing an "agnostic" platform.

5.4   Future research

My dissertation shows that digital real-time data technologies, or "big data technologies," provide greater transparency of organizational and interorganizational processes as well as improved coordination and control opportunities stemming from digitally mediating such processes in technologically embedded environments. Both of these points warrant further research to fully grasp their effects on organization.

5.4.1   Technology-induced transparency

First, future research should revisit the effects of technology-induced transparency. My empirical study on the effects of technology-induced transparency on the development of interorganizational trust and control (see Essay 3) shows that there are multiple types of transparency with varying effects on organizational processes. Yet, the topic of technology-induced transparency – or transparency in general – in organization theory and strategic management is to date underdeveloped. Despite some early conceptualizations of transparency within organizations (Bernstein 2017, Hansen and Flyverbom 2015, Stohl et al. 2016) and a growing number of empirical analyses (Bernstein 2012, Lamming et al. 2004, Ringel 2019, Schnackenberg and Tomlinson 2016), a more systematic conceptualization and research agenda could prove insightful. Conceptually, we need an analysis of how different forms of transparency influence organization. A particular point of interest would be whether and how the power effects of technology-induced transparency or "traditional" transparency of purposeful disclosure differ (see Essay 3 for a distinction between technology-induced operational transparency and "traditional" disclosure transparency). In this regard,

distinguishing the mechanisms bringing about transparency, as well as the relationship between objects and audiences of transparency, could paint a more complete picture of the phenomenon.

Future empirical research could focus on how greater technology-induced transparency affects organizational culture. Essay 2 has shown that this transparency affects how managers and engineers increasingly understand their surrounding realities as visualized and manipulable through digital data. As ever more organizational processes are digitalized, creating more technology-induced transparency, this might effect a broader change in organizational culture. Future research should explore how such a change in organizational culture affects processes of decision-making, strategy-making, or innovation in organizations. Many of these processes need to recognize managers' limited ability to really know their environment. Where technology-induced transparency provides both greater knowledge of the environment and increased perception of being able to know the environment, it might influence how much information managers seek before taking decisions, the options they consider, or their willingness to experiment.

To drive this development even further, what if the focus of transparency were to shift to the personal level, where the object of transparency moves to individual employees' tasks and performance? In my dissertation, the objects of transparency were impersonal technical processes largely disconnected from individuals' incentives. All my case relationships welcomed transparency as a legitimate coordination and control tool. This acceptance might well lie within the object and audiences of technology-induced transparency of interorganizational processes. While in some cases it was possible to break the transparency down to individual employee level, organizations did not do this systematically and their general interest lay in creating, using, and analyzing the transparency for process optimization. It remains to be seen whether acceptance is equally high when the object of transparency are employees and individuals. Broader societal conversation suggests widespread acceptance of transparency, yet academic work suggests a more careful weighing of the benefits of both transparency and secrecy (Albu and Flyverbom 2019, Bernstein 2012, Costas and Grey 2014, Hansen and Flyverbom 2015, Ringel 2019). It would be of great interest to study whether and how technology-induced transparency is used to identify employees' tasks and performance, to what ends, and to which audiences this transparency is directed. How would different configurations of object, audience, and purpose interact with outcomes such as efficiency, acceptance, or problems arising in the workplace?

5.4.2 Technological embeddedness

Second, the construct I conceptualized as "technological embeddedness" (Essay 1) needs further refinement. For this, a first step would be to measure it. I defined it as the extent to which organizations engaging in collaborations use digital real-time data to monitor, control, and optimize specific interorganizational tasks. As such, we could measure the concept by three groups of indicators, each group comprising a range of individual metrics. First, the kind of digital data exchanged is relevant: How detailed and timely is it? This will affect the possible level of monitoring of technologically embedded relationships. More voluminous and varied data allow a more detailed virtual representation of the task(s) at hand, whereas velocity of data determines the temporal accuracy of virtual representations. Then, the use of digital data exchange and analysis is relevant: How and to what ends the virtual representations are used determines the level of control exerted in technologically embedded relationships. Where organizations use representations mainly in operations, the degree of technological embeddedness would be lower than in cases where organizations also use them strategically in negotiations. Further, sporadic use indicates lower technological embeddedness than more systematic use. There are also nuances in systematic use: Insights from the representations could be tied back to specific contract terms or to individual managers' incentive systems. I suggest measuring each of the metrics on a scale from 0 (low) to 1 (high). The mean score of all measures could then provide a single measure between 0 and 1, indicating low or high technological embeddedness, respectively. Such a measurement would allow quantitative testing of the effects of high and low technological embeddedness on collaboration processes.

Third, the extent to which the digital infrastructure allows optimization of intra- or interorganizational tasks should be measured. Organizations can use the virtual representations to independently optimize specific tasks and processes with or without involving their partner. Furthermore, organizations can choose whether they develop the digital infrastructure on their own or in collaboration with those partners with whom they share technological embeddedness. My findings have shown that case relationships that used and developed representations jointly might experience different effects of technological embeddedness. Therefore, these measures might not directly indicate how high technological embeddedness is in a relationship, but rather indicate different types of technological embeddedness. I would therefore propose studying configurations of technological embeddedness in addition to how high or low it is in a given relationship. For this, a qualitative comparative analysis (Ragin 2008) to identify and learn more about different types of

technological embeddedness would be very insightful. My assumption is that, while it is possible to denote the degree of technological embeddedness as a single number, there is also value in exploring how different shapes of technological embeddedness affect organization.

It could be of great interest to combine the measurement of technological embeddedness with a network analysis approach. My empirical setting has looked at technological embeddedness only from a dyadic perspective. Yet, triadic or multilateral relationships could equally well be technologically embedded. Future research should consider such empirical settings to analyze how technological embeddedness manifests in dispersed or centralized networks. For this, the measurement of the construct could contain an additional measure that accounts for the number of partners engaging in a specific task or network of tasks of technologically embedded interorganizational processes, how centralized or dispersed the governance of collaboration in this digital infrastructure is, and whether there are clusters of highly technologically embedded relationships. Adding this additional dimension to the construct of technological embeddedness would provide an avenue to study the effects of digital real-time data technology-based infrastructures on network governance.

There is also a temporal question at the network level: How does an organization manage its varying levels of technological embeddedness when some relationships are considerably more technologically embedded than others? Such a situation would likely require a staged management approach, aiming to steadily increase technological embeddedness over time. Yet, is this always beneficial for all relationships or is there a case for keeping some relationships at a lower level of technological embeddedness? Furthermore, this reasoning implies that technological embeddedness always increases. Yet, we do not know whether technological embeddedness could also decrease while simultaneously maintaining or increasing the value of the relationship in question. Thus, future research should address the question of how changes in technological embeddedness affect the profitability of the focal organization as well as the value of a relationship and the broader network.

Beyond measurement, the organizational and interorganizational effects of "technological embeddedness" also demand further attention. As organizations use digital real-time data to mediate organizational and interorganizational processes, they also have a considerably greater ability to coordinate and control them. Digital real-time data-based technological embeddedness therefore provides the cognitive basis to coordinate and control the form of technology-induced transparency and the action basis to implement such

coordination and control through digital infrastructures. Yet, as my discussion on the measurement of technological embeddedness above has indicated, this concept may take many different shapes. Analyzing how these different shapes manifest in and affect organizations would be of great interest. I see two angles in particular.

One angle to explore would be the interaction between the functionalities of technologically embedded processes and how users use the technologies. Technological embeddedness builds on the interplay of multiple actors and how people use tools to do tasks (Pentland and Feldman 2007). In the case of technological embeddedness, it could be of interest to explore which interactive functionalities a technologically embedded process provides at its interfaces. This could affect the interaction of employees and managers with the digital artifact, as well as how the digital artifact might affect the interactions between employees, managers, customers, and external stakeholders. Thus, how employees, managers, customers and external stakeholders in technologically embedded processes engage with each other through digital artifacts, as well as with the digital artifact itself, could be assessed further (D'Adderio 2011, Pentland and Feldman 2007, 2008).

Another interesting angle to technological embeddedness is how it might exist at the organizational level. My dissertation shows that greater levels of technological embeddedness allow process-level compartmentalized management of interorganizational tensions (Essay 2) and faster development (or deterioration) of interorganizational trust (Essay 3). While I show potential pitfalls of greater technological embeddedness, I also explain how this improves coordination and efficiency. Thus, organizations may equally choose to increase technological embeddedness internally between workflows, units, or departments. Such an application of technological embeddedness to the organizational level could bring similarly drastic changes. Consequently, future research should examine the manifestations and implications of technological embeddedness in intraorganizational networks as a characteristic of inter-unit ties and interactions. For instance, Essay 2 in this dissertation has shown how digital real-time data privilege swift responses to operational issues, relocating certain tasks and decisions from higher hierarchical management to lower hierarchical operations positions. Similar changes to where tasks and decisions are made could possibly occur as internal technological embeddedness increases.

5.5   Conclusion

In the last 5–10 years, the increasing availability of affordable connectivity paired with cost-efficient access to data storage and analysis have given rise to a range of new digital real-time data technologies, often referred to as "Big Data," "Internet of Things," or "Artificial Intelligence." All of these technologies record digital trace data – data produced as a given process occurs, representing this process through a variety of numerical indicators – and subsequently collect, store, and analyze these data to either optimize the recorded processes or create new products and services. Organizations realize great cost savings and innovation promise in applying these technologies to their internal and external processes. Within the interorganizational realm specifically, collaborating partners see great potential for conducting highly complex and knowledge-intensive service delivery at cost-efficient levels. While there is great interest and hype around these technologies in the business world with new products and services appearing frequently, academic research on the managerial and organizational implications of such technical solutions has been sparse. Yet, there are two characteristics of these new "interorganizational big data technologies" that warranted academic investigation into such implications: technology-induced transparency and digital mediation. First, digital trace data are voluminous, real-time, and varied. Combined with advanced analytics and high connectivity levels, digital trace data create a new quality of operational transparency. Second, digital mediation allows the immediate and often remote manipulation of represented processes. This level of insight and the ability to act upon it in real time provides a range of new, more exact governance mechanisms, which may not only transform the digitalized operational processes but also the relationship itself.

In this dissertation, I have explored seven such cases of "interorganizational big data technologies." My conceptual and empirical analysis has shown that these technologies create operational transparency over specific digitally mediated interorganizational processes. The technology-induced transparency allows collaborating organizations to gain a better understanding of complex interorganizational processes and identify avenues for optimization in real time, and the digital mediation allows them to act on these insights immediately. In the three essays of this dissertation, I have contributed to strategic management and organization theory by exploring interorganizational relationship within digitally enhanced environments. First, I have coined the term "technological embeddedness" to describe a characteristic of digitally enhanced interorganizational relationships. Understanding interorganizational relationships as technologically embedded lets the researcher define what exactly digitalization

does in these relationships and thereby provides a starting base from which to analyze changes in collaboration processes. Second, I have shown how technology-induced transparency shapes how managers perceive their collaborative relationships and which issues they attend to in technologically embedded processes. Where digital real-time data technologies create what I term "orthodox spaces," managers temporarily suspend tensions and focus on a subset of organizational goals. Third, I have shown that technology-induced transparency can lead to automated controls replacing interorganizational trust, regardless of a partner's actual (un)trustworthy performance and behavior.

Looking back at the starting point of this conclusion on the absence of knowledge about these new "interorganizational big data technologies," I would say that my dissertation has made a start in analyzing the phenomenon for both practitioner and academic audiences. Taking the technical solutions as a starting point, I have analyzed what these technologies do in collaborative relationships, that is, how they have transformed coordination and cooperation activities between partners. While outlining how these technologies can improve coordination of operational interorganizational processes, I have highlighted the importance of non-digitalized cooperation issues such as balancing tensions and purposefully building trusting relationships with strategic partners. To summarize my findings for practitioners, I would say that these technologies do indeed carry much potential, but that they should complement rather than replace strategic partner management practices. For academic audiences, I have shown that interorganizational big data technologies and the transparency they create have substantial effects for interorganizational relationships and their management. Yet, this dissertation is but a starting point for a much broader research agenda to understand organizations and their collaborative relationships in digitally enhanced business environments.

6. References

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